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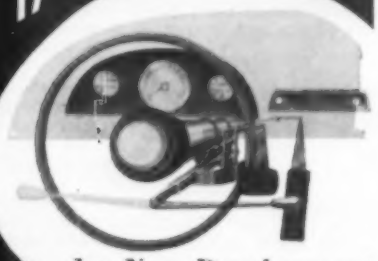

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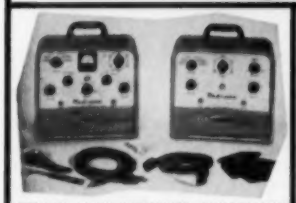

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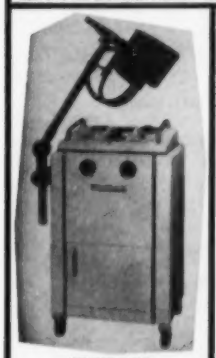

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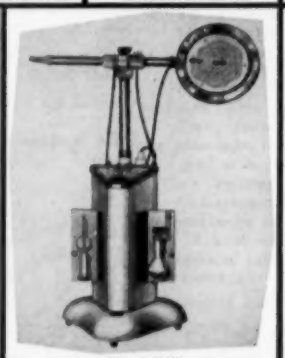

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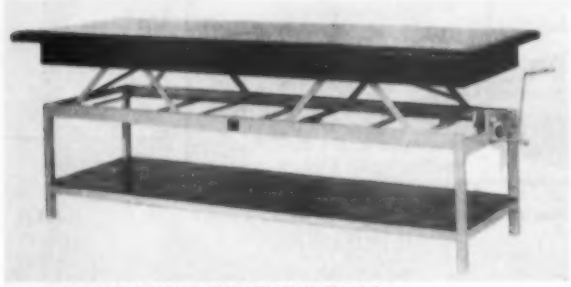

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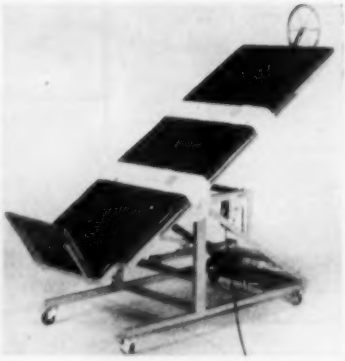

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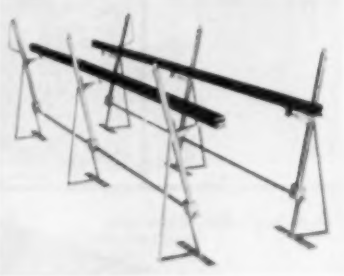

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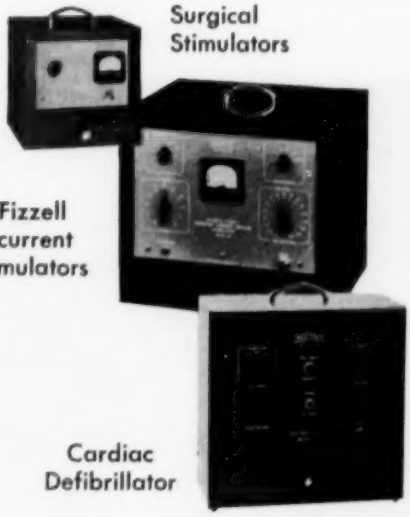

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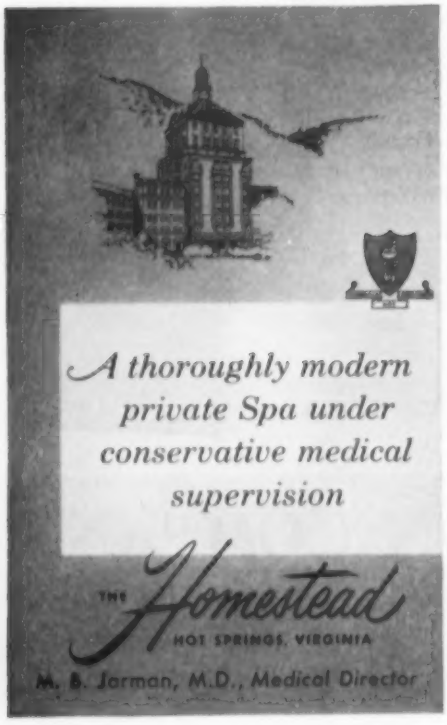
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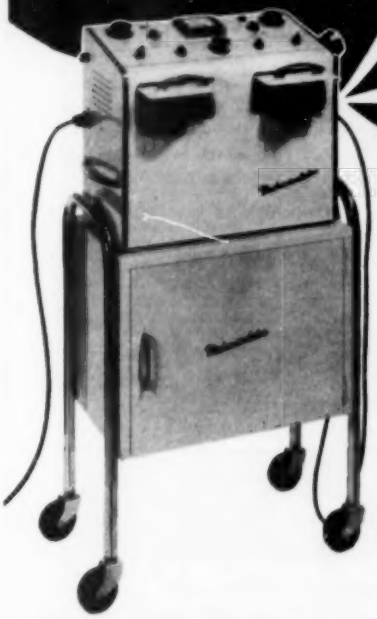

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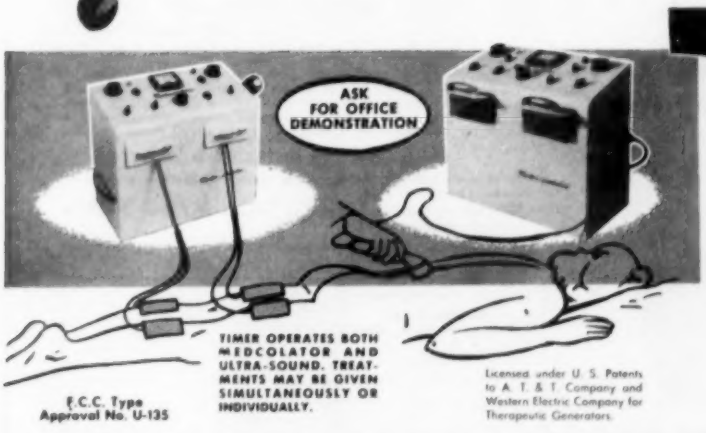

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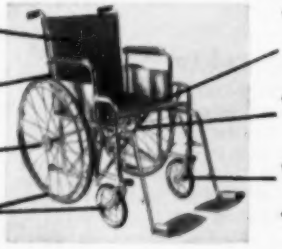

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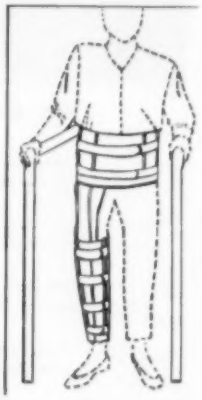

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Significance of the Pharynx in Rehabilitation of Poliomyelitis Disabilities in the Cervical Area

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Salt Lake City

The patency of the pharynx and the adequate performance of the mouth, pharynx, and larynx in deglutition, control of respiration, and speech are essential objectives in efforts of rehabilitation of the poliomyelitic-impaired muscles of the hyoid and cervical area. If principal attention is given to recovery of head support, these performances of the bulbar area may be impeded. Premature effort of head support, before adequate muscular strength is recovered in the pharynx, is particularly liable to effect pharynx occlusion.

Examination of the mouth and pharynx provides useful information regarding function of the muscles supporting these organs, and also of displacements in general relations within the hyoid area. Roentgenographic examination of the area during swallow, speech, and inflation maneuvers, after coating these cavities with radiopaque material, provides further valuable information in this regard.

The possible contribution of therapy accomplishing mobilization in the mouth, pharynx, and larynx to general rehabilitation in the cervical area deserves consideration, though it is not subject to objective definition or quantitation.

Clinical Observations

The 47 patients who had had bulbar poliomyelitis and who provided experience here cited have been further described in other publications.[1-5] These patients have each been evaluated by standardized clinical and roentgenographic methods and most of them have been seen over periods of weeks or months incident to continued rehabilitation effort.

Apposition of Tongue, Hyoid, and Larynx to Cervical Spine, with Occlusion of the Pharynx: The most striking disability of the pharynx reflecting impairment of its adjacent musculature is that of complete occlusion by compression between lordotic cervical vertebrae and the combined mass of tongue, hyoid, and larynx.[5] This pattern of displacements is considered to be an effect of weakness of the suboccipital muscles, allowing anteflexion of the cranium upon the cervical vertebral pedestal, and retrodisplacement of the skeleton of the face, including the mandible and the hyoid structures dependent from it (fig. 1). An essentially similar pattern of displacements has been described by Sjöberg,[6] who interpreted this as a disproportionate motor strength of the muscles suspending the hyoid from the base of the cranium.

This extent of disability apparently had accumulated progressively in the early convalescence of these patients. There are a variety of possible additive factors of its cause, including the use of rolled towels placed in the suboccipital area to facilitate extension of the head and access to tracheostoma. This may cause exaggeration of cervical lordosis. It is probable that insufficient support of the head during early stages of semirecumbent and upright position may also exaggerate the craniovertebral anteflexion.

It is highly probable that disuse of the mouth, pharynx, and larynx in either respiration or deglutition was an important mechanism in development of the severe contractures which fuse the head, mandible, hyoid, and upper cervical vertebrae into an essentially unmoving mass.

The initial therapeutic objective in this clinical situation was that of reestablishing patency of the pharynx, which was accomplished by prolonged cephalic traction applied by means of a plastic palatal mould and suboccipital band, both held to a brace affixed to a tilted table. After

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Fig. 1 — Apposition of tongue, hyoid, and larynx to cervical spine, with occlusion of the pharynx. *a.*, Adult patient, 15 months after acute poliomyelitis. Note the diminution in diameter of the cervical area, the anteflexion on the neck, and the transverse corrugations in the submental and anterior cervical area. *b.*, Lateral roentgenogram of same patient. Note the approximation of hyoid bone to mandible, and of both to the lordotic cervical spine. The lateral processes of the hyoid bone extend on either side of the vertebral body, and the adjacent portion of the pharynx is occluded. Small amounts of barium in the oropharynx and immediately above the pharyngoesophageal sphincter outline the upper and lower extent of this occlusion.

pharynx patency was achieved, an intensive program of manual mobilization of the cervical and submental area, speech therapy, and pneumatic inflation of the mouth and pharynx was instituted.

Inferior or Anterior Displacement of the Tongue, Hyoid, and Larynx: Weakness or contracture of the suspensory muscles found when the tongue, hyoid, or larynx is displaced in an inferior or anterior direction (fig. 2*a*) may be further evaluated by selected passive maneuvers. Thus, if the submental muscles are critical in support of the hyoid structures, in compensation for weakness of the styloid and posterior digastric muscles supporting the hyoid from the base of the cranium, the hyoid will be noted to descend within the neck as the jaw is widely opened (fig. 2*b*). In the normal subject, the hyoid remains unchanged in position with opening or closing of the mouth, as this is evaluated by palpation of the hyoid body. A more difficult distinction is that of weakness of the styloid suspensory muscles from contracture of the pretracheal, sternohyoid, and sternothyroid muscles. The latter can be evaluated by extension at the neck, in which circumstance the hyoid structure will normally rise. If the pretracheal muscles are severely contractured as a result of adjacent paralysis, long immobilization, and local inflammation, as may be associated with an adjacent tracheostoma, the hyoid and larynx will fail to rise with extension at the neck. Further evaluation of strength of these suspensory muscles is obtained by examination of the oral and pharyngeal cavities and by observations during performance of inflation and swallow, as described subsequently.

Visual Examination of the Mouth and Pharynx at Rest: If support of the hyoid structures is deficient, the posterior portion of the tongue may be visibly displaced downward within the mouth. Palpation by tongue blade or examiner's finger may further confirm this deficiency

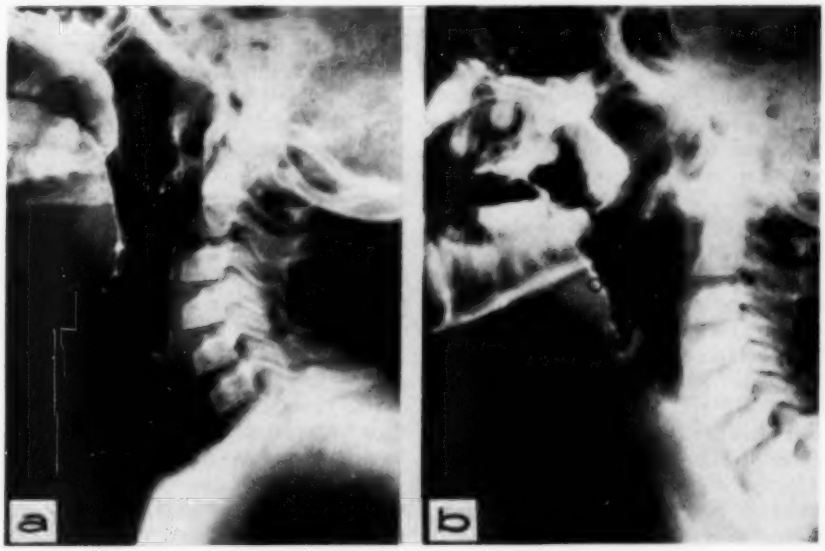

Fig. 2 — *a.*, Patient 15 years of age, 4 years after acute bulbar-spinal poliomyelitis, with severe residual weakness of the pharynx constrictor and suspensory musculature. Note expansion of palatopharyngeal isthmus, the meso- and laryngopharynx, with inferior and anterior displacement of tongue, hyoid, and larynx. *b.*, Same patient. Mouth open, oral respiration. Note descent of tongue and barium-outlined lateral groove (indicated by oval) of tongue.

of support. Gagging or retching induced by this stimulation will invalidate this method of evaluation, for the motion of the posterior part of the tongue and hyoid at these times is downward. An asymmetry of tongue and hyoid support may be demonstrated, if the one side of the tongue is lower and, per palpation, less well supported than the other.

Additional clues of displacement of structures adjacent to the pharynx may be provided by inspection of the posterior pharyngeal wall, which may reveal an anterior protrusion in a patient with severe cervical lordosis, or with posterior displacement of the structures of the face and mouth in relation to the cervical vertebrae and with or without cervical lordosis. If cervical scoliosis or other mechanism of lateral malalignment of the cervical vertebrae exists in relation to the structures of the face and mouth, this anterior protrusion of the cervical vertebrae upon the posterior pharyngeal wall may be displaced to either side.

Observation during Inflation, Phonation, and Swallow: Roentgenography is of much assistance in evaluating inflation, phonation, and swallow in that it provides objective demonstration of abnormalities and also some comparison in consecutive examinations during the convalescent period. Standard roentgenographic technics can be used during posed performances, such as inflation or prolonged phonation of "open" tones. For observation of swallow, an automatic serial recording technic, as by Fairchild or Perez-Sanchez camera or by cineradiography, is indicated if available.

The simplest evaluation procedure is that of *inflation* of the combined mouth and pharynx cavities.* An adequate procedure of inflation depends, of course, upon the patient's capacity to prevent abnormal penetration of the air column through the palatopharyngeal isthmus and the lips; it may be necessary to manually close the nose or the mouth to compensate for paralytic deficiency of the isthmus or of the lips. During inflations at moderate pressures (10 to 20 mm. Hg), the pharynx may be found to be much expanded in anteroposterior diameter vertically or transversely (fig.

*An additional procedure of separate inflation of the mouth is described elsewhere[6] as a maneuver evaluating control of the retro-oral portal.

3*a*). This abnormal expansion reflects the composite weakness of the suspensory and constrictor muscles of the pharynx. The latter can be qualitatively evaluated by differential lateral expansion at either side or at the meso- or hypopharynx as these are visualized in anteroposterior roentgenograms. The inferior displacement represents primarily weakness of the suspensory musculature.

The maneuver of inflation may also demonstrate atrophic deficiencies in the mass of muscles adjacent to the pharynx. Thus, in figure 3*b* is shown a gross deficiency of volume of the prevertebral muscles.

Incident to *phonation*, a surprising degree of distention of the pharynx and displacement, analogous to those observed in oropharyngeal inflation, may be observed (fig. 3*a*). In speech there is considerable vertical motion of the hyoid and larynx, simulating that in swallow, and visual or cinefluorographic observation during intermittent production of tones of high pitch or articulated speech may demonstrate deficiency of this vertical motion.

The adequacy of strength of elevation of the hyoid structures is critical in the performance of *swallow*. Strength of this motion can be evaluated by attempted opposition to this elevation by the thumb and first finger of the examiner clasped from either side in the notch between hyoid bone and thyroid cartilage; if strength of elevation is deficient, an attempted swallow may thus be prevented. The water employed as the test substance will be spilled upward as a nasal regurgitation or into the larynx, depending upon associated impairments of the intrinsic muscles of the pharynx and the larynx. If the muscles accomplishing elevation of the hyoid structures during swallow are moderately impaired, their weakness may also be demonstrated by a moderate extension at the neck, in which position a greater range of motion is apparently required for adequacy of swallow action, and failure of attempted swallow may, again, occur. It is apparent that the presence of contractures of the pretracheal muscles limiting adequate ascent of the hyoid structures must be evaluated prior to these tests of adequacy of swallow performance.

In some patients an interesting variation of direction of motion of the hyoid

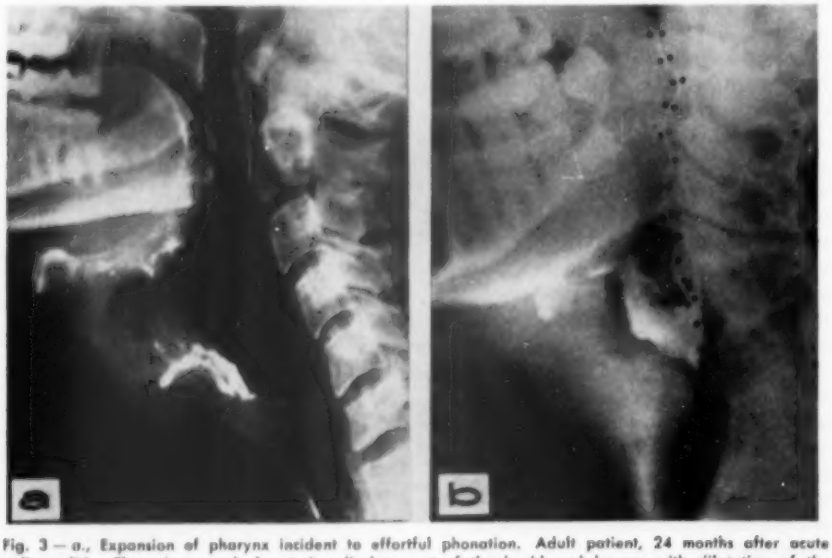

Fig. 3 — *a.*, Expansion of pharynx incident to effortful phonation. Adult patient, 24 months after acute poliomyelitis. There is a marked anterior displacement of the hyoid and larynx, with dilatation of the laryngopharynx and vestibule of the larynx and lesser dilatation of trachea and cervical esophagus. *b.*, Demonstration of diminution of mass of prevertebral muscles incident to phonation. Adult patient, 31 months after acute poliomyelitis. Note posterior wall of the pharynx (indicated by paired dots) is in irregular contour, in parallel to anterior margins of vertebral bodies.

structures was found whereby these were moved anteriorly rather than upward incident to swallow. This alternative direction of motion was apparently an adequate compensation in some patients having marked weakness of the muscles suspending the hyoid structures from the cranium. Additional information of relative strength of these suspensory muscles joining the tongue, hyoid, and larynx to the base of the cranium or to the mandible is obtained by comparison of roentgenographic observation of swallow with the patient in a supine and in an upright position.[4]

Discussion

The functionally related structures of mouth, pharynx, and larynx are suspended from the mandible, the posterior portion of the facial skeleton, and the cranium by the complex arrangement of muscles shown in figure 4. This suspensory arrangement makes possible the mobility of the pharynx and larynx in relation to the head and neck, so that their essential performance as the portal of respiration and alimentation can continue unimpeded despite variations in head and neck position.

The basic motion of the pharynx in swallow is ascent within a space which is maintained in area by the postural musculature of the neck. The abrupt elevation of the pharynx structures is integrally related to closure of the palatopharyngeal isthmus[3] and of the larynx, as well as to opening of the pharyngoesophageal segment.[4]

Impairment of performance of the mouth, pharynx, and larynx may result from weakness of cervical postural muscles and displacement in relation of head and neck, with compression at the pharynx and larynx, or with an extension at the neck which increases the effort required for successful swallow. Conversely, if weakness of the intrinsic or suspensory muscles of the mouth, pharynx, and larynx is present, the patient may develop adaptive motions of head and neck that facilitate performance of swallow. These latter adaptive motions of protrusion and elevation of mandible and face are typically combined with an anterior displacement of the structures of the anterior pharyngeal wall — a motion which in swallow may be an adequate alternative to elevation of these structures, if their elevating musculature is disabled.[4] These adaptive motions, such as tilting, turning, or extension at the neck, may be retained in convalescence long after they are no longer required for facilitation of swallow.

In acute bulbar poliomyelitis, measures facilitating later recovery of function of the mouth, pharynx, and larynx may be overlooked. Principal concern and attention are directed to general bodily care,

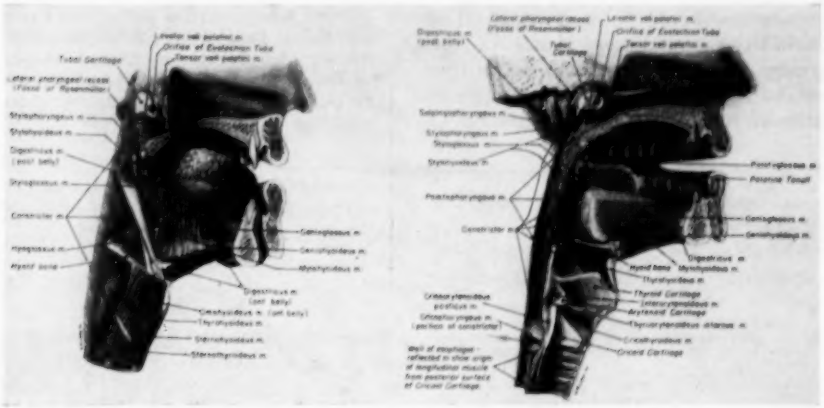

Fig. 4 — Dissections demonstrating musculature of the pharynx. *a.*, Lateral wall of the pharynx, from lateral aspect. Tubal cartilage and auditory canal are transected. Note suspensory arrangement of styloid, palatal, submental, and digastric muscles. *b.*, Lateral wall of the pharynx, from medial aspect. Tip of tubal cartilage is excised to show origin of salpingopharyngeus from inferior aspect of cartilage.

and to respiration. Disability of the pharynx and larynx impaired by poliomyelitis is compounded by their disuse. The function of swallow is expectedly absent and re-evaluated only cautiously and infrequently. The functions of valving of respiration and of speech are commonly eliminated by the open tracheostoma. The patient quickly adopts nonvocal means of communication and often finds them not only adequate for his needs but also the distinctive expression of similarly disabled associates. Thus, the bulbar handicap is accumulated and exaggerated.

In these patients, the evaluation of the bulbar impairment is a necessity. The general identification of a disability of swallow is sufficient to prevent risk of aspiration by ill-guided swallow attempts. The therapy of this disability requires evaluation of head-neck relation, of contractures of the pretracheal muscles limiting normal ascent of the pharynx in swallow, and of particular impairments of the valvular mechanisms adjacent to the route of the bolus. This evaluation is much facilitated by roentgenographic studies by which the disability may be specified and therapy evaluated.

Awareness of the processes exaggerating disability in the bulbar area leads readily to their control or correction. In particular, the continued use of the mouth, pharynx, and larynx as a route of respiration and mechanism of communication should be encouraged. The clinically observed coincidence of the greater degree of contractures in the area of the face, mouth, and pharynx in patients having the least utilization of the pharynx is of meaningful therapeutic implication. The optimal form of guided utilization of the mouth-pharynx-larynx area is that of speech therapy. The motions of the upper pharynx in swallow and speech are basically similar,[3] thus the efforts of speech provide appropriate exercises which may accumulate to adequate elements of swallow.

Summary

The objective of motor rehabilitation in the cervical area is not mere alignment and normal relations of parts while at rest, but normal range of strength and motion requisite to swallow, control of respiration, and speech. The role of cervical postural mechanisms in disability of the mouth, pharynx, and larynx is described.

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Changes in Peripheral Blood Flow Produced by Short-Wave Diathermy

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Alvin J. Harris, M.D.[2]
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with the technical assistance of
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Although short-wave diathermy applied to human subjects and dogs has been shown by various investigators to effect a rise in tissue temperature, a concomitant increase in blood flow has not been universally established. Wise,[1] using the venous occlusion plethysmographic method, noted a definite rise in blood flow in the forearm of ten human subjects. Wakim and his associates[2] performed the same type of study on the upper and lower extremities and reported an increase in circulation in the majority of the subjects, while a small percentage demonstrated an actual decrease. The same workers, using a flow meter, generally found an augmentation in blood flow in the hind limbs of dogs, with a reduction in some instances. Siems and co-worker,[3] also working with dogs, observed a consistent increase in local circulation.

On the other hand, Kemp and his associates[4] reported that diathermy produced a decrease in blood flow in the femoral artery of anesthetized dogs, despite a rise in deep tissue temperature of two to three degrees. Flax and his associates[5] obtained variable results in the digits of human subjects, and Millard,[6] using the rate of clearance of radioactive sodium in the muscles of the lower extremity, also observed inconstant changes. On the basis of their studies on dogs exposed to diathermy, Richardson and his group[7] concluded that the therapeutic dosages most frequently employed for humans probably would be insufficient to induce appreciable changes in blood flow in deep tissues.

Because of the conflicting results obtained by different investigators, it was decided to study the effect of short-wave diathermy on blood flow through the forearm of normal human subjects, using the venous occlusion plethysmographic method. The purpose of the investigation was twofold: (1) to determine whether or not diathermy applied in a manner similar to that used clinically would produce an increase in circulation in a normal forearm, and (2) if this did occur, to locate the vascular bed or beds mainly responsible for the change.

Clinical Material and Method

Twenty-six experiments were performed on 13 normal healthy subjects ranging in age from 23 to 50 years. Five were women and eight were men. The segment type of venous occlusion plethysmograph, containing a heater and propellor blades, was used to obtain blood flow records from the forearm (fig. 1). The apparatus was properly insulated to protect the skin of the forearm and wrist from heat concentrated in the metal as a result of the application of the diathermy. An air transmission recording system was used, consisting of a Brodie's bellows and an ink-writing lever which recorded on a long-paper kymograph. All studies were performed in a temperature-regulated room with the temperature at 24 C. and the humidity at 56 per cent. During the entire period of observation, attempts were made to minimize psychic stimuli as much as possible.

The diathermy apparatus used operated at a frequency of 27.12 megacycles per second, corresponding to a wave length of 11.06 meters. A capacitance

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[1, 2]From the Department of Physical Medicine and Rehabilitation, University of Illinois, College of Medicine. This study was partially supported by funds from the Graduate College Research Board of the University of Illinois.

[3]From the Department of Surgery, Chicago Medical School.

field was formed by two air-spaced plate electrodes, one placed over the shoulder and the other over the dorsum of the hand, while the forearm was enclosed in the water-filled plethysmograph (fig. 1).

In an attempt to maintain the dosage of diathermy as constant as possible in the different experiments, the output of the machine* was always kept at an arbitrary setting of 25, as indicated on the output meter on the instrument board, while the relationship of the plates to the skin of the dorsum of the hand and shoulder was altered until the subject felt a comfortable sensation of heat equally in both sites. It is recognized that the use of such a purely subjective response to control energy input may lead to the employment of variable dosages of diathermy, even for the same individual on different occasions. However, at present no reliable method for the objective determination of energy input is available.[8] In each experiment diathermy was applied for 34 minutes.

After the subject was left in the temperature-regulated room for approximately 40 minutes, to permit equilibrium to be reached between the temperature of the trunk and limbs and that of the environment, the forearm was placed in the plethysmograph and the apparatus was made watertight according to the technic previously described.[9] Two blood flow experiments were performed on each subject. In the first the plethysmograph was filled with water at 32 C. and maintained at this level throughout the experimental period. In the second test, performed about one week later, the bath temperature was kept at 45 C. In order to be certain that the full effect of the heat on the cutaneous vessels had been achieved before diathermy was applied, the control period with the bath temperature at 45 C. was frequently prolonged to about one hour. By means of the heater and propellor blades in the

*In all experiments a Liebel-Flarsheim frequency-controlled short-wave diathermy instrument was used (model SW-660).

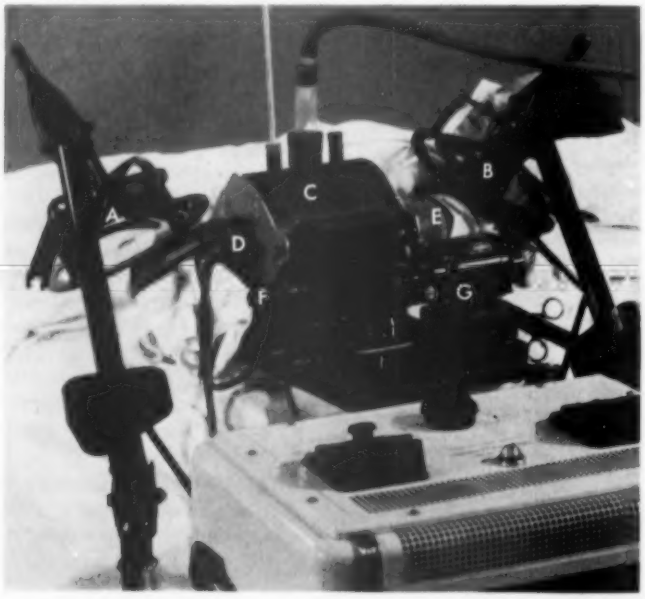

Fig. 1 — Position of air-spaced plate electrodes in relation to upper extremity. *A* and *B*, Electrodes placed over dorsum of hand and shoulder respectively. *C*, Plethysmograph. *D*, Modified blood pressure cuff, used for application of an arterial occlusion pressure at the wrist so as to prevent vascular effects of hand from affecting blood flow curve obtained from forearm. *E*, Modified blood pressure cuff around lower portion of arm, used for application of a venous occlusion pressure in order to obtain a blood flow reading from forearm. *F*, Heating coil, which penetrates the apparatus and is used to maintain temperature of water in plethysmograph (bath temperature) at desired level. *G*, Electric motor, attached to a shaft which penetrates apparatus and is connected to propellor blades for agitation of water in plethysmograph.

plethysmograph, the bath temperature for each set of experiments was maintained within one degree of the desired level during the entire period of observation.

In each experiment two to three blood flow recordings were taken in rapid succession every 3 to 4 minutes during the control period of approximately 45 minutes, during the application of diathermy, and in the postdiathermy period. The experiment was terminated when it appeared that the blood flow level had fallen to that of the control period. In all, 45 to 55 blood flow readings were obtained on each subject at a specific bath temperature. The average duration of the experimental period was 2 hours.

The results of each experiment were plotted on graph paper with the abscissa representing time and the ordinate, blood flow. The excess blood flow over and beyond the control level was obtained separately for the period of application of diathermy and for the postdiathermy period. This was accomplished by determining the area under each portion of the curve, using a planimeter. The total excess blood flow elicited by short-wave diathermy was obtained by adding the two figures.

It was believed that with this approach much more pertinent information regarding the effectiveness of diathermy as a vasodilating procedure would be available than from the usual method of comparing the percentage increase over the control level of the blood flow reading representing the maximal peak of the vascular response. The latter approach appears to be of little value, since it in no way takes into consideration the magnitude of the change in blood flow occurring both during and after application of diathermy. In fact, comparison of data obtained in such a manner may lead to misleading or fallacious conclusions.

Results

Bath Temperature of 32 C.: Thirteen experiments were performed on the forearm at a bath temperature of 32 C., with the control reading averaging 1.8 cc. per minute per 100 cc. of limb volume (range of 0.9 to 2.7 cc.).

With the beginning of the period of diathermy, in each instance there was an almost immediate increase in blood flow (fig. 2*A*), with the peak of the response occurring in an average of 30 minutes (range of 20 to 34 minutes) after the procedure was started (figs. 3 and 4).

After the period of diathermy was terminated, in eight cases the blood flow continued to rise slightly, reaching a peak in an average of 6 minutes (range of 2 to 11 minutes) (fig. 3). In the remaining five cases, the curve of increased blood flow fell during the postdiathermy period from the peak attained during diathermy (fig. 4). For the entire group the average duration of the increase in circulation in the postdiathermy period averaged 45.7 minutes (range of 31 to 66 minutes). At no time was there a significant fall below the control blood flow level in the postdiathermy period.

In all but two cases, the amount of excess blood flow observed during the application of diathermy at a bath temperature of 32 C. was less than that of the postdiathermy period (table 1). The average of the excess blood flow noted during diathermy was 33.5 cc. (range of 8.6 to 75.8 cc.), as compared with 44.9 cc. (range of 13.9 to 98.7 cc.) for the postdiathermy period. The total excess blood flow elicited by application of diathermy was an average of 78.5 cc. (range of 22.5 to 173.9 cc.).

Bath Temperature of 45 C.: Thirteen experiments were performed on the forearm at a bath temperature of 45 C., with the control readings averaging 7.2 cc. per minute per 100 cc. of limb volume (range of 4.7 to 9.5 cc.).

At the beginning of the period of diathermy, in each instance there was an almost immediate rise in blood flow (fig. 2*B*), with a peak of the response occurring in an average of 27 minutes (range of 16 to 33 minutes) after the procedure was started (figs. 3 and 4).

After the period of diathermy was terminated, in five cases the blood flow continued to rise slightly, reaching a peak in an average of 4 minutes (range of 2 to 12 minutes) (fig. 3). In the remaining eight cases, the curve of increased blood flow fell during the post-

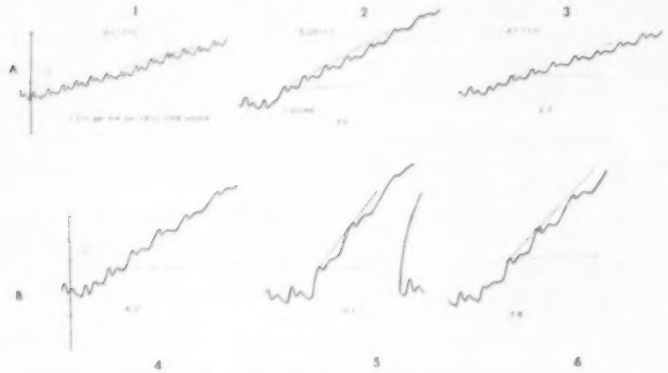

Fig. 2 — Reproductions of actual records of blood flow obtained from forearm. The abrupt ascent of baseline is the result of sudden application of a pressure of 70 mm. Hg around the arm (venous occlusion pressure) sufficient to prevent all blood in forearm from flowing out, at least for the first few seconds, while not interfering with arterial inflow. Steepness of slope is a reflection of rate of blood flow into limb. Calibration scales, on the left side of figure. Time in fifths of second. *A*, Blood flow readings obtained at bath temperature of 32 C.: 1. control period; 2. during application of diathermy; 3. after termination of diathermy. *B*, Blood flow readings obtained at bath temperature of 45 C.: 4. control period; 5. during application of diathermy; 6. after termination of diathermy. Figures under curves indicate calculated blood flow in cc. per minute per 100 cc. limb volume derived from record.

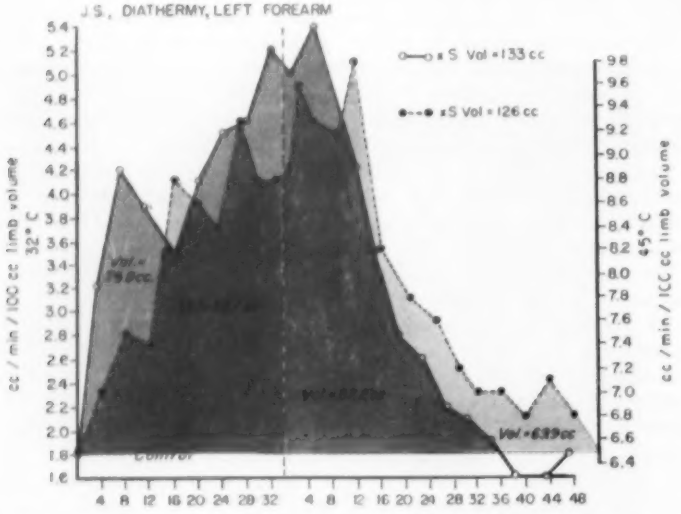
J.S., DIATHERMY, LEFT FOREARM
J S Vol = 133 cc
J S Vol = 126 cc
cc / min / 100 cc limb volume 32° C
cc / min / 100 cc limb volume 45° C
Vol = 69.9 cc
Control
4 8 12 16 20 24 28 32 4 8 12 16 20 24 28 32 36 40 44 48

Fig. 3 — Graphs depicting excess blood flow entering forearm of subject J.S. as a result of application of 34 minutes of diathermy. Abscissa represents time in minutes and ordinate, blood flow per minute per 100 cc. limb volume. Area enclosed by open circle and solid line designates excess blood flow obtained at bath temperature of 32 C.: during diathermy, 75.8 cc.; after diathermy, 57.2 cc.; total excess blood flow, 133 cc. Area enclosed by solid circle and dotted line designates excess blood flow obtained at bath temperature of 45 C.: during diathermy, 56.1 cc.; after diathermy, 69.9 cc.; total excess blood flow, 126 cc.

diathermy period from the peak attained during diathermy (fig. 4). For the entire group the average duration of the increase in blood flow in the postdiathermy period averaged 36.9 minutes (range of 9 to 16 minutes). In five cases the blood flow curve after reaching the baseline significantly dropped below it. In two other instances a moderate drop occurred and in the remaining six either a slight fall or no fall was observed.

In eight out of thirteen cases the

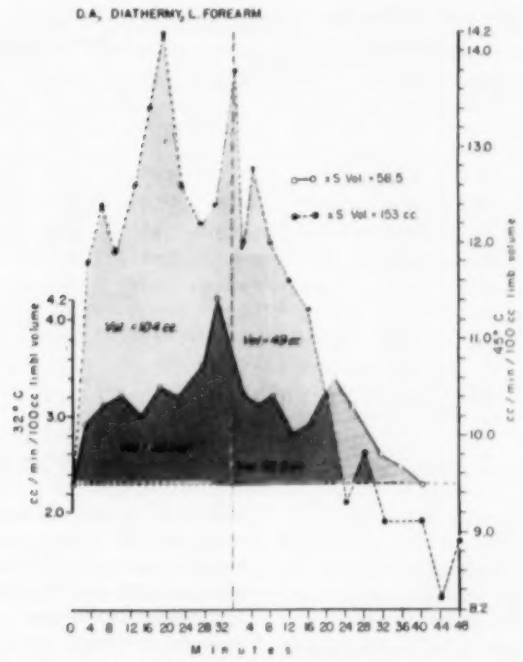

Fig. 4 — Graphs depicting excess blood flow entering forearm of subject D.A. as a result of application of 34 minutes of diathermy. Abscissa represents time in minutes and ordinate, blood flow per minute per 100 cc. limb volume. Area enclosed by open circle and solid line designates excess blood flow obtained at bath temperature of 32 C.: during diathermy, 32.3 cc.; after diathermy, 26.2 cc.; total excess blood flow, 58.5 cc. Area enclosed by solid circle and dotted line designates excess blood flow obtained at bath temperature of 45 C.: during diathermy, 104 cc.; after diathermy, 49 cc.; total excess blood flow, 153 cc. Fall below control level of 9.5 cc. per minute per 100 cc. limb volume noted at termination of period of observation.

amount of excess blood flow observed during the application of diathermy was greater than in the postdiathermy period, in one both were the same, and in four, the greater increase was present in the postdiathermy period (table 1). The average excess blood flow during the period of diathermy was 53.5 cc. (range of 29.4 to 104.0 cc.), as compared with 44.8 cc. (range of 8.4 to 104.6 cc.) for the postdiathermy period. The total excess blood flow elicited by the application of diathermy was an average of 98.3 cc. (range of 44.2 to 153.0 cc.).

Comparison of the Results Obtained at Bath Temperatures of 32 and 45 C.: Comparison of the graphs representing the blood flow response to diathermy at a bath temperature of 32 C. with those obtained at 45 C. revealed certain similarities and differences. Under both circumstances there was a definite increase in blood flow through the forearm during the period of application of diathermy and for some time afterward (figs. 3 and 4). The location of the peak of the blood flow response during the period of diathermy was also approximately the same for the two bath temperatures, that is, near the end of the period of application. Furthermore, under both conditions, in approximately one-half of the cases there was a continued rise in blood flow in the postdiathermy period, with the peak being reached in 4 to 6 minutes after the termination of diathermy.

Among the observed differences in responses was a longer period of increased blood flow after the termination of diathermy with a bath temperature of 32 C. than at 45 C. (45.7 minutes as compared with 36.9 minutes). Another was the finding that in no instance did the readings in the postdiathermy period significantly fall below the level of the control at a bath temperature of 32 C., while this occurred seven times at 45 C.

Table 1: Effect of Short-Wave Diathermy on Blood Flow in the Forearm.

Subject	Bath Temperature 32 C.				Bath Temperature 45 C.			
		Excess Blood Flow				Excess Blood Flow		
	Control	During	After	Total	Control	During	After	Total
D.A.	2.3	32.2	26.2	58.5	9.5	104.0	49.0	153.0
G.M.	1.7	8.6	13.9	22.5	6.7	33.6	104.6	138.2
P.B.	1.4	25.2	56.8	82.0	8.3	54.4	46.6	101.0
E.B.	1.9	28.6	40.6	69.2	7.7	47.4	45.3	92.7
L.L.	1.5	12.5	27.7	40.0	6.3	63.9	22.5	86.4
A.P.	2.0	18.6	16.9	35.5	4.7	50.1	50.7	100.8
M.S.	1.8	22.3	59.8	82.1	9.1	46.7	30.7	77.4
J.L.	3.7	30.2	34.0	64.2	7.1	60.7	8.4	69.1
J.S.	1.8	75.8	57.2	133.0	6.5	56.1	69.9	126.0
A.H.	0.9	43.2	48.0	91.2	5.1	52.9	40.3	93.2
S.B.	2.4	23.9	32.4	56.3	7.1	29.4	14.8	44.2
A.S.	1.5	40.6	71.7	112.3	6.7	42.1	55.6	97.7
M.P.	1.4	74.3	98.7	173.9	8.4	54.0	44.5	98.5

Finally, at a bath temperature of 32 C., the excess blood flow during the period of application of diathermy was generally less than that of the postdiathermy period (an average of 33.5 cc. as compared with 44.9 cc.), while at a bath temperature of 45 C., the reverse was true (an average of 53.5 cc. for the period of diathermy, as compared with 44.8 cc. for the postdiathermy period).

In the group as a whole, the total excess blood flow elicited by the application of diathermy was much less at a bath temperature of 32 C. (an average of 78.5 cc.) than at 45 C. (an average of 98.3 cc.). When the responses of a specific individual to the two bath temperatures were compared, the following data were obtained: In six subjects the total excess blood flow was definitely greater at a bath temperature of 45 C. than at 32 C. (D.A., G.M., P.B., E.B., L.L., and A.P.), while in four the results were approximately the same (M.S., S.L., J.S., and A.H.); in two subjects (S.B. and A.S.) the response was somewhat greater at 32 C. than at 45 C., while in only one (M.P.) was it definitely greater (see table 1).

Discussion

The results of the present study support the view that when diathermy is applied to an extremity in dosages comparable to those used clinically, invariably a definite increase in blood flow will be produced. Evidence has also been accumulated to indicate that at a bath temperature of 45 C. the vascular bed primarily affected by the diathermy is in the muscular tissues of the limb. The basis for arriving at such a conclusion will be presented subsequently.

It is generally accepted that at a bath temperature of 32 C. the vessels in the limb, both superficial and deep, are in a physiologic state, that is, neither excessively constricted nor excessively dilated. Such a situation is similar to that produced by an environmental air temperature of 25 C. Under such circumstances, therefore, any increase in blood flow elicited by diathermy could be attributed to vascular changes either in skin and subcutaneous tissue, in muscle, or in both.

On the other hand, at a bath temperature of 45 C. the heat of the water acts as a very potent agent for the production of almost maximal vasodilatation of the surface vessels and possibly of those in the superficial muscle layers. As a result, it can be assumed that the arterial system, in the cutaneous and subcutaneous tissues at least, is in such a state of relaxation that other vasodilating procedures should have little or no additive effect. On this basis, the fact that in all subjects a significant increase of blood flow in the forearm was elicited by diathermy at a bath temperature of 45 C. has great importance. For,

with the cutaneous and subcutaneous vessels fully dilated, such a change can be attributed only to an augmentation in circulation in the muscle tissues.

It is conceivable that a higher bath temperature would have a greater effect, but it has been found that 45 C. is the maximal temperature which can be tolerated comfortably by most individuals. Beyond that level, pain is produced, which acts as a strong vasoconstricting stimulus to counteract in part the direct vasodilating effect of the heat.

The fact that in all of the subjects but one the excess blood flow resulting from diathermy at a bath temperature of 45 C. was either greater than, the same as, or slightly less than that at 32 C. is also of interest. It suggests that the vascular changes in circulation at a bath temperature of 32 C. could be caused by the same mechanisms operating at the higher temperature, namely, vasodilatation of muscle blood vessels. It is realized of course, that such a view is based on indirect evidence. Opposed to it is the possibility that a critical muscle temperature may be required to elicit an increased muscle circulation and that such a level is not reached at 32 C. but is at 45 C.

To explain the finding that in six subjects diathermy produced a much greater increase in blood flow at a bath temperature of 45 C. than at 32 C., it is necessary to review briefly the mechanisms which come into play in the dissipation of heat from the body. As soon as heat accumulates in the muscles, after the use of an agent such as diathermy, a gradient is created between the artificially produced high tissue temperature and that of the environment. The steeper the gradient, the more rapid is the loss of heat by conduction and convection from the interior of the limb to the skin, and by radiation from this structure to the environment.

Another mechanism is purely a vascular one, involving vasodilatation of the vessels in the muscles initiated by the heat. The resulting increase in circulation acts as an effective means of removal of heat, provided the temperature of the tissues surrounding the vessels is higher than that of blood. Furthermore, the greater the tissue temperature, the more marked is its vasodilating effect. With the source of heat deposition constant, the magnitude of the increase in muscle blood flow elicited by diathermy therefore will vary inversely with the efficiency of the mechanism operating to cause loss of heat to the environment by convection, conduction, and radiation.

At a bath temperature of 32 C. an adequate gradient exists between the high muscle temperature produced by diathermy and the temperature of the water surrounding the limb, thus contributing to considerable loss of heat from the muscles through convection and conduction.

On the other hand, at a bath temperature of 45 C. the existing gradient between tissue and environmental temperatures is obviously much less, and hence the heat deposited in the muscle by diathermy tends to pile up to a greater degree than at 32 C. The higher muscle temperature acts as an increased stimulus to cause further dilatation of muscle vessels, this manifesting itself in the form of a more marked muscle blood flow.

The greater response to diathermy frequently observed at a bath temperature of 45 C. may have some clinical application. For example, if a jacket of heat could be produced around a limb simultaneously with the use of diathermy to the area, the vasodilating effect of the latter agent might be enhanced or a smaller dosage might be adequate. It is possible that such a situation could be produced by the combined use of diathermy and infrared or diathermy and fomentations covering the limb.

Summary and Conclusion

The results of the present study on human subjects support the view that diathermy has a consistently potent vasodilating effect and that at a bath temperature of 45 C. the action is primarily upon the muscle vessels. Whether the same situation exists at a bath temperature of 32 C. cannot be stated conclusively, although there is some suggestive evidence in support of this view. The finding in about one-half of the cases of

a greater vascular response to diathermy at a bath temperature of 45 C. than at 32 C. may have clinical implication and application.

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SLIDEFILM PINPOINTS QUACK DEVICES

More than a dozen mechanical quack devices and gadgets play the villain in a color slidefilm with sound just released by the AMA Bureau of Investigation. The 15-minute filmstrip, "Mechanical Quackery," is supplemented by narrative description of the devices and the fraudulent uses to which they have been put. It is available on loan to medical societies, service and fraternal groups and schools.

The film is described as a public education experiment. The slidefilm is a flexible and effective medium to use in exposing some of the quacks to the public. It may be used by medical societies or individual doctors as a tool in a concerted program to fight quackery. It is valuable, too, when used by lay or professional groups to alert their members or the community to the harm caused by quacks who use these worthless machines and devices as cure-alls.

Twenty-five sets of the film and record are in the AMA Bureau of Investigation lending library. Requests should be addressed to the Bureau. *(Note:* Equipment needed to show "Mechanical Quackery": A sound slidefilm projector — or a filmstrip projector with a 33 1/3 RPM turntable. Strip has 60 frames. Record is 12-inch.)

Application of Ultrasound to Experimentally Induced Neuromas in Dogs

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Successful treatment of painful neuromas by means of ultrasonic vibrations has been reported by a number of clinical investigators in this country and abroad.[1-7] The exact manner in which the relief of pain occurs is not, however, clearly established. Some investigators,[8, 9] believe that the thermal effect is most important; other workers,[1, 10, 11] believe that the nonthermal effects are most important; and still others believe that a combination of both thermal and nonthermal effects are responsible.[3, 11] Rubin and Kuitert[1] have demonstrated that, in successfully treated patients, the surgically removed neuromatous tissue, when studied histologically, does not show any change (coagulation necrosis or cellular infiltrates) attributable to thermal factors. It was their contention that the pain-relieving properties of ultrasound were probably due to mechanical alterations occurring in the peripheral tissues perhaps as a result of the vigorous micromassaging action or stirring effect described by Lehmann and Biegler.[12]

In an effort to obtain a more scientific evaluation of the effect of ultrasonic vibrations on neuromatous tissue, the problem was taken into the animal experimental laboratory.

Method

Four dogs were given "Napental" (sodium pentobarbital), 25 mg. per kilogram of body weight, intravenously. When the animals were completely anesthetized, the sciatic nerves in all four were exposed and sectioned bilaterally, at the mid-thigh level. A segment of nerve approximately ½ inch long was removed and the distal and proximal ends of the severed nerves were allowed to retract. The muscle was approximated without sutures and the skin was closed with silk.

Of the four animals, two died of pneumonia during an epidemic in the animal room. Exactly 45 days after the sciatic nerve section, the two surviving animals were given a series of 12 ultrasound treatments to the shaved right thigh. The left hind limbs of both animals served as untreated controls. An intensity of 1.5 watts per square centimeter was employed for a period of 8 minutes during each treatment. The ultrasound generator had a frequency of 1 megacycle per second and an applicator surface of 5 square centimeters. The 12 treatments were extended over a 16-day period; the longest period without treatment was 2 days. Oil coupling was used in each case and the applicator head was moved well beyond the healed incision to insure adequate radiation of the proximal end of the severed sciatic nerve.

Two days after the last treatment the dogs were anesthetized and the sciatic nerve trunks were carefully exposed. Photographs were taken in situ (fig. 1), and both the proximal and distal ends of the severed sciatic nerve were carefully dissected, removed, and immediately placed in formalin fixative.

Observations

Exposure of the sciatic nerves two days following the last ultrasonic treat-

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This study was conducted at the Surgical Research Unit, Ft. Sam Houston, Texas.

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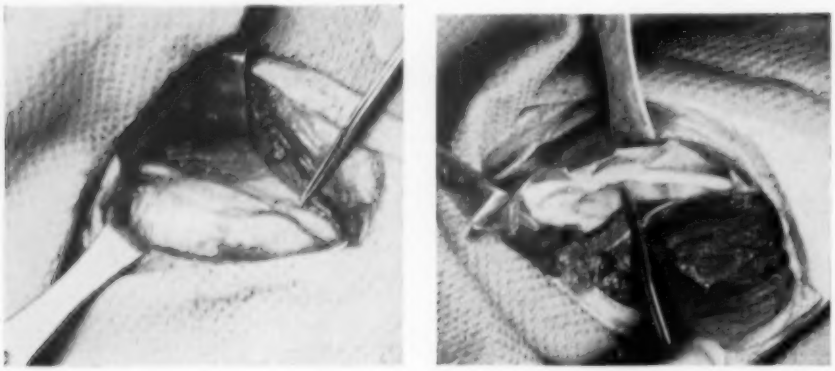
Instructor, Department of Surgery, George Washington University Hospital, Washington, D. C.

Pathology Service, Brooke Army Hospital, Ft. Sam Houston, Texas.



1A 1B

Fig. 1 — Forceps at proximal neuroma: *A*, treated limb; *B*, untreated limb.

ment of the right hind limb in each of two dogs revealed gross neuroma formation of the proximal end of the nerve of both treated and control sides. The sciatic nerve neuroma of the treated limb appeared slightly smaller in both animals than the untreated control of the opposite side; however, the amount of fibrous versus nerve tissue components could not be accurately evaluated on gross inspection. It was also observed that the proximal neuroma on the treated side, in both animals, was attached to the distal segment by a thin fibrous band, whereas the untreated proximal neuroma, in both animals, was attached to the distal segment by a much larger and thicker fibrous band. There was no evidence on gross examination of any destructive change in the soft tissues — skin, muscle, connective tissue, or nerve tissue. Vascularity was excellent in both the treated and untreated hind limbs.

Histologically, there was no evidence of coagulation necrosis, cellular infiltrates, cavitation, or any other form of destructive process in either of the treated neuroma tissues. Proximal and distal segments failed to demonstrate any specific change of a thermal nature as a result of 12 treatments with ultrasonic vibrations of a clinically therapeutic intensity of 1.5 watts per square centimeter for 8 minutes during each application. Comparison of the control and treated tissues did not reveal any significant differences between the two in either the same or in different animals. The microscopic appearance of treated and untreated proximal neuromas is demonstrated in figure 2.

An interesting observation was made relative to the skin at the incision sites. On the treated side the skin appeared somewhat atrophic, the incision scar less dense, and the suture line less conspicuous than in the corresponding control limb. This may possibly be likened to the reported effect of ultrasound on keloid formation.[13]

Discussion

The clinical usefulness of ultrasound in the treatment of pain arising from neuromas has already been mentioned. The exact basis for the occurrence of this observed phenomenon has not been experimentally determined. Gersten[14] has pointed out the difficulties inherent in evaluating the relative importance of thermal and nonthermal effects of ultrasound in living systems. However, the statement has been made that clinical intensities of ultrasound as employed in physical medicine have no effect, as far as conduction in peripheral nerves is concerned, other than that produced by rise in temperature.[8] This conclusion has not been borne out by the experiences of others,[1, 10, 15] and still other investigators express the opinion that the action of therapeutic ultrasound on nerve tissues is mainly the result of a combined thermal and mechanical interference with the conductivity of the nerve.[3]

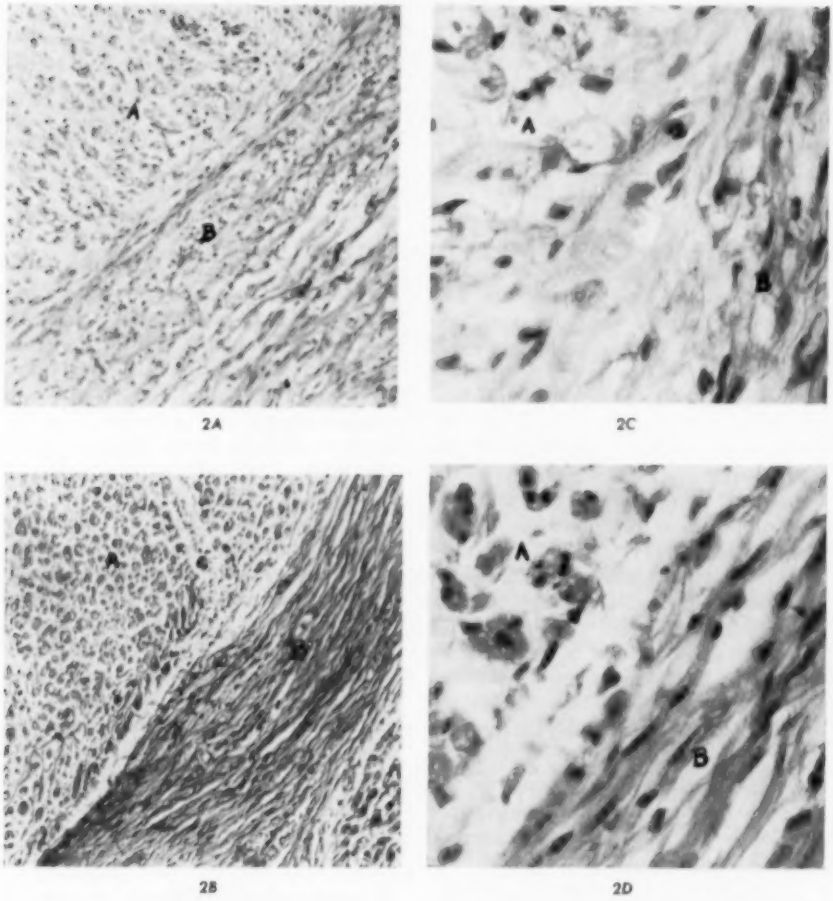


Fig. 2 — A, Treated proximal neuroma (low power); B, untreated proximal neuroma (low power); C, treated proximal neuroma (high power); D, untreated proximal neuroma (high power). A = nerve; B = connective tissue.

Wulff and co-workers[11] observed a reversible depression of the spontaneous activity in the ganglia of the crayfish ventral nerve cord after the application of high intensity ultrasound. A maximum temperature increase of 1 C. was measured in their experiments. This was in direct opposition to an observation that a rise in temperature, by means of direct heat, of 1 C. between the range of 26-30 C. may produce an increase in frequency of discharge of single units of about 4-5 per second. From these findings the authors concluded that "the effect of ultrasound on these spontaneously active neurones is mediated by physical factors other than the simultaneously occurring but slight temperature change." The same experimenters concluded from experiments on the frog's spinal cord that ultrasound produces effects on the neurones of the spinal cord which are primarily dependent on physical factors other than temperature, such as periodic pressure changes, particle acceleration, radiation pressure, and temperature and pressure changes associated with cavitation. Equally impressive is the experimental study conducted by Anderson and others[9] on the effects of ultrasonic energy on nerve and spinal cord tissue in the dog. These investigators used a stationary technic with a single dose of 5 watts per square

centimeter for a duration of 6 to 10 minutes and observed paralysis of the hind legs and tail of five of seven dogs. The sciatic nerve appeared to be more resistant to the same intensity of ultrasound. Histologically, the destructive effects were much less apparent in the sciatic nerve than in the spinal cord when compared with the histological changes induced by direct heating to corresponding temperature elevations. On the basis of their experiments, they pointed out that, while most of the physiologic and histologic changes could be explained by the heating effect of ultrasound, a nonheating effect was supported by two findings: "(1) the occurrence of marked destruction of the cord when temperatures recorded in the spinal cord were as low as 42° to 43° C. after application of ultrasonic energy, and (2) sciatic nerves which had their action potential completely blocked by application of ultrasonic energy showed much less histological evidence of the unusual regular pattern of degeneration of myelin which is an effect of heat than sciatic nerves in which the action potential had been similarly completely blocked by direct heating."

Our observations as reported in this paper do not supply a final answer to the problem of thermal versus nonthermal effects of ultrasound. However, the use of accepted clinical dosages, duration, and frequency of treatment, and the absence of specific histological changes in treated as compared with nontreated experimentally induced neuromatous tissue in the dog would, in our opinion, tend to support the nonthermal rather than the thermal concept of the therapeutic effectiveness of ultrasonic vibrations. The entire problem is, however, still speculative, and is recognized as such, for while the experimental results tend to confirm our previously described observations in man, there is still no absolute proof that transmission of pain is physiologically altered by therapeutic dosages of ultrasound. On the other hand, the recent observations of Alyea and his associates[16] on the effect of low intensity ultrasound in raising the vibration perception threshold in man, as measured by the Bio-thesiometer, provides a more accurate recording of the probably nonthermal effect of ultrasound on peripheral nerves. There is also the well-recognized fact that direct heat, in any form, will not alter neuromatous pain in man, whereas ultrasound has been an effective physical agent in this condition.

Summary

The application of clinically therapeutic intensities of ultrasound at a frequency of 1 megacycle per second, a duration of 8 minutes, and for a total of 12 daily treatments, spaced over 16 days, to experimentally induced sciatic neuromas in dogs failed to produce any histological changes in the treated tissues. The absence of such changes, while insufficient to warrant any definitive conclusions, tend to confirm the belief that the pain-relieving properties of ultrasound, when applied to painful neuromas in man, are probably the result of nonthermal rather than thermal factors. This is further supported by the knowledge that clinically applied heat from any other modality has no effect on neuromatous pain in man, whereas ultrasonic vibrations are highly effective.

Further experimental studies are required to separate more accurately and scientifically the effective components of clinically applied ultrasound.

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Discussion

Justus F. Lehmann (Columbus, Ohio): I would like to compliment the authors on their attempt to put their clinical impressions on a scientific basis. They treated neuromatous tissue in two dogs with ultrasonic doses comparable to those applied to relieve persistent pain occurring as a result of such neuromas in amputees. No histologic changes were observed under their set of experimental conditions. In spite of these negative findings, it would be of interest to know whether there was any evidence of functional changes in the nerves thus treated. For instance, it would be interesting to know if the sensitivity of the neuroma to pressure or other stimuli was altered in spite of a histologic appearance identical to that of the untreated controls. It also would be of interest to obtain some information on the rise of temperature at the nerve during irradiation. This type of measurement would also serve as a check of the ultrasonic intensity at the treated nerve.

Rubin and Kuitert, in agreement with Tepperberg and several European authors, observed that the pain in cases with neuromas occurring after amputation was relieved even when other available treatment methods had failed. As the authors have pointed out, we do not know how this observation can be explained on a physiologic or biophysical basis, however I feel that the available experimental data suggest a thermal, rather than a nonthermal, mode of action. The following experimental facts are known. Treanor, Lambert, Krusen, and Herrick clearly demonstrated that the changes in action potentials and of the conduction velocity of peripheral nerves, whether reversible or not, were entirely due to the rise of temperature produced as a result of the absorption of ultrasonic energy. The same changes could be reproduced quantitatively by heating the tissues to corresponding temperatures. Also, the difference in sensitivity of various types of nerve fibers to ultrasound could be quantitatively explained on the basis of the difference in sensitivity to heating. Unfortunately, a correlation between the most sensitive fibers and the fibers carrying pain impulses could not be established as an explanation for the clinical claim that ultrasound relieves pain, because in this particular study it was not known which type of fibers conducted pain impulses. Similar observations were made by Hueter, Ballantine, and associates, and

documented by a motion picture by Schmitz demonstrating simultaneous temperature and nerve action potential changes.

We found that changes of the chronaxie of the peripheral nerve in situ were also explained on the basis of the heating effect of ultrasonic energy and prevented by cooling. Anderson, Herrick, Krusen, and Wakim found a striking similarity between the histologic appearance of peripheral nerves exposed to heat and to ultrasound. Beyond this, Rosenberger could demonstrate a selective rise of temperature in a sciatic nerve exposed to ultrasound in situ, where the nerve became hotter by several degrees than the overlying or underlying soft tissue structures. This finding shows that the heating effect of ultrasound is a specific one which cannot be reproduced by the application of heat with another modality.

The quoted results of the experiments of Fry and his associates are not applicable as an explanation of the therapeutic effects discussed, since Fry used ultrasonic intensities which were more than one hundred times higher than those used in this study. The intensities used by Fry and associates produce, as we could confirm in other experiments, a different type of lesion, which probably is not due to the heating effect; however, this type of lesion has not been observed at lower intensities.

In summary, the experimental data so far available suggest that the ultrasonic effects on the peripheral nerve can be explained on the basis of the selective rise of temperature in the nerve rather than by nonthermal effects. Some of these thermal effects were reversible and this fact perhaps might explain why histologic changes were not found in this study. So far, conclusive evidence for the occurrence of nonthermal effects is not available, but our knowledge of the changes in nerve function under therapeutic application of ultrasound is lacking in many respects. It can be debated whether or not the described experimental findings are an explanation for the clinical results obtained by therapeutic application; however, an approach such as used by the authors seems to be desirable and helpful to increase our knowledge in this respect.

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Vital Capacity as an Index of Respiratory Muscle Function

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The metabolic needs of the body require ventilation of the lungs. This is accomplished by constant rhythmical contraction of the respiratory muscles. A reserve of this function is necessary to take care of needs that are greater than ordinary. Although lung volume measurements to measure these reserves were made over 200 years ago, it was not until the remarkable work of John Hutchinson,[1] in about 1846, that a careful critical study was done, using thousands of lung volume determinations. The largest volume of air that an individual could move he called "vital capacity."

Vital capacity measurements as an index of respiratory reserve have since been extensively used to great advantage in lung and heart disease, and numerous reports can be found in the literature. Extensive statistical surveys have also been undertaken to establish normal values. It has been only recently, however, that vital capacity measurements have become widely recognized as an aid in determining respiratory muscle weakness.[2]

Our observations, in the examination of a great number of patients with respiratory muscle weakness due to poliomyelitis and other causes, confirm what already has been reported in the literature respecting the usefulness of vital capacity. However, our experience has also demonstrated the need for caution in the interpretation of results. It is the purpose of this paper to point out practical criteria so that vital capacity can be used as a reliable index of respiratory muscle function.

Technic

Vital capacity is usually measured with the patient erect. It is our practice, however, to use the supine position as the reference since all patients can be studied in this position. When vital capacity is taken in the erect position, the supine position values are used as reference.

Although vital capacity can be accurately measured by several types of instruments, we prefer the spirometer used for recording basal metabolism. It gives an accurate, permanent record, the vital capacity compartments can be determined with much greater ease and certainty than with the other methods, and the co-ordination and co-operation of the patient can be better documented or demonstrated. The chief disadvantage is that the measurements are more time consuming than with the other methods. Figure 1 illustrates such a tracing taken with the patient using a respirator except when she performed maximal breathing efforts several times.

There are several important points in the technic that must be considered to get reliable results. Carefulness is always necessary. The person doing the tests should receive special training. In order to do these tests on patients with respiratory muscle weakness, the operator must also have experience in the use of respiratory equipment. Since some of the patients may have tracheotomy tubes and require tracheal suctioning and manual coughing, experience in the management of these problems is also necessary.

Vital capacity should be measured under as ideal and uniform conditions as possible. Testing of the patient immediately after meals should be avoided. The patient should not be exhausted or apprehensive, no matter what the cause. If the patient has a complicating illness, such as pneumonia or a kidney infection,

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From the Respiratory Center for Poliomyelitis, Rancho Los Amigos Hospital, Hondo; and the Departments of Physical Medicine, and Internal Medicine, College of Medical Evangelists, Los Angeles.

The Respiratory Center is aided by an annual grant from the National Foundation for Infantile Paralysis, Inc.

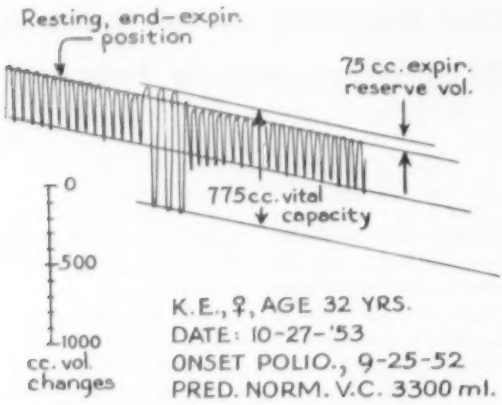

Fig. 1 — Vital capacity and its compartments.

the readings then obtained could be influenced by the intercurrent condition.

It is necessary that the patient understand the procedure so that he can cooperate with the technic. He must exert his utmost effort. Since vital capacity measurement depends upon the patient's effort, there is danger of decreasing his effort, either consciously or subconsciously, when it is to his advantage. With a metabolic apparatus, whether or not the patient is limiting his efforts can easily be demonstrated. If he rebreathes for several minutes with the carbon dioxide absorber removed, he will be forced to take maximal breaths as the carbon dioxide concentration accumulates. Figure 2 demonstrates such a case.

The presence of pain, especially when it is increased by maximal breathing, is likely to decrease the vital capacity effort. Likewise, disturbance of the emotions may cause inco-ordination and limitation of the muscular effort. It is well to keep in mind, however, that the true vital capacity is never less than the observed value.

One of the common causes of fallaciously low readings is an obstructed airway. This may be the result of tracheal or bronchial mucus or laryngeal spasm caused by reflex choking or apprehension. In some cases the tracheotomy tube may occlude a good proportion of the tracheal cross section. Bronchospasm may cause an incorrect, low reading. The characteristics of a respiratory tracing aid in the diagnosis of bronchospasm since flow rate is slow, especially near the end of expiration. Restrictive clothing, brace, corset, or body jacket about the chest and abdomen may decrease the observed measurement. Abdominal distention may also be a factor.

Obviously, vital capacity measurements are not significant unless they are relative. Standards have therefore been determined. It has been found that age, sex, and body height and weight influence such standards. There are other factors that cannot be easily measured, such as the patient's occupational and athletic habits, extent of bed rest, and his body build. It is known that the position of the body has some effect on the vital capacity in even the normal subject — it may have marked effect in the presence of respiratory muscle weakness.

We find it advisable, however, not only to report the percentage normal vital capacity, but also to express the actual capacity of the patient. The standard should be reviewed at regular intervals, especially for children, otherwise the results become quite inconsistent. The standards we use[3] are an integration of the normal standards of Baldwin and co-workers[4] for adults, and the standards of Ferris and his co-workers for adolescents and children.[5, 6]

Strength, Endurance, and Adaptation

Although there are many factors that change the significance of vital capacity,

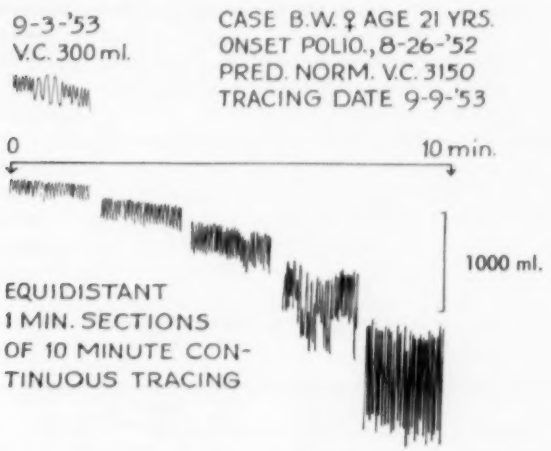

Fig. 2 — Respiratory tracing of patient who gives a false low vital capacity.

a certain qualified meaning can justifiably be attached to specific vital capacity measurements as expressed in per cent normal. This would be true particularly in subjects with appreciable muscle weakness, who do not show marked disturbance of the normal muscle breathing pattern, who do not have heart or lung complications, and in whom there is no rigidity of the chest wall.

It has been our clinical experience that during the early progressive stage of poliomyelitis a physician should be especially alert to the possible need of artificial respiration when the vital capacity drops below 50 per cent. As Ferris and his co-workers[2] suggest, it may even be well to use artificial respiration as a test at this point. If the patient shows definite relief from fatigue when placed in the respirator, then artificial respiration appears indicated. On the other hand, if the vital capacity is found to be only 25 per cent normal, respiratory aid is necessary in practically every case.

In the late recovery phase from severe weakening of the respiratory muscles, irrespective of cause, vital capacity takes on a different meaning. In these cases we have found that a vital capacity as low as 20 per cent normal may permit complete freeing from respiratory aid, but the breathing pattern has to be largely diaphragmatic. Such a patient may be adequately ventilated with no signs of fatigue. On the other hand, we have found it physiologically necessary to permit a patient to get part-time respiratory aid when the vital capacity was as high as 38 per cent. Such patients usually have relatively severe diaphragmatic weakness.

Breathing endurance is definitely improved as the patient passes from the early acute stage to the chronic stage. This increased endurance is usually, but not necessarily, reflected by increase in vital capacity. A certain vital capacity during the early stage may mean much less breathing endurance than the same capacity during the chronic stages. To illustrate, two patients who have approximately the same per cent normal vital capacity will be compared (see table 1).

Cases 1 and 2: Both are postpoliomyelitic patients. Case 1 is just now beginning to be freed from the respirator only a few days following the febrile stage. Although he has a good breathing pattern and the respiratory muscles are only slightly weakened, he is now able to breathe only 25 minutes without becoming subjectively fatigued. He showed a transient vital capacity drop of 150 cc. during this period. Case 2 has the same vital capacity (per cent normal) and is now completely free of respiratory equipment. She is active in the rehabilitation gymnasium but still shows quite marked weakness in all extremities and trunk, and is moderately limited by the respiratory muscle weakness.

Table 1: Comparison of Two Patients with Approximately Equal Per Cent Normal Vital Capacity

	Case 1 P. J.	Case 2 A. J.
Sex	Male	Female
Age, years	33	20
Weeks since onset of poliomyelitis	2	29
Vital capacity, cc.	2,150	1,575
Per cent normal	48	49
Breathing tolerance*	25 min.	Full time
Symptoms	Muscle fatigue	None
Activity	None	Beginning to walk

*Note the discrepancy in breathing tolerance even though per cent normal is the same.

Table 2: Changes in Vital Capacity as Compared to Breathing Time During Convalescent Period in One Patient

Date	Vital Capacity,* Cc.	Per Cent Normal*	Time out of Respirator
11-5-52	Onset of Poliomyelitis		
1-9-53	Admission to Rancho Los Amigos Hospital		
1-9-53	75	4	None
4-24-53	50	3	None
8-25-53	119	7	1 min.
12-7-53	115	7	1 min.
3-12-54	100	6	5 min.
6-5-54	19 months after onset		
6-24-54	225	12	40 min.
8-18-54	225	12	1 hr., 18 min.
8-18-54	Discharged home		
11-10-54	200	10	3¾ hr.
1-12-55	230	12	7½ hr.
5-13-55	250	12	About same
7-6-55	Beginning to use glossopharyngeal breathing to supplement		
	250	11	10 hr.
10-19-55	250	11	About same

*The discrepancies between the vital capacity figures and per cent normal are due to changing vital capacity standards as the child grew.

Improvement in performance is not always associated with corresponding vital capacity changes. This may be illustrated by another case, this time during the chronic stage.

Case 3: In K. W., an 11-year-old girl, the onset of poliomyelitis occurred 3½ years ago. Her trunk and extremities are essentially nonfunctioning. Breathing is entirely neck accessory. Table 2 illustrates the tolerance of breathing compared to vital capacity changes. Although both vital capacity and breathing tolerance improved until about 19 months after onset, breathing tolerance continued to increase, even though vital capacity remained unchanged.

When the development of the respiratory weakness is gradual, as in progressive muscular dystrophy, it appears that the body adapts itself considerably more to the impaired breathing than in situations in which the problem develops suddenly. This is another example of discrepancy between what might be predicted from the vital capacity findings and the actual breathing ability. We shall describe a remarkable case.

Case 4: G. G., a 17-year-old boy, has progressive muscular dystrophy — observed since birth. There is marked weakness of the extremities, trunk, and neck musculature. The patient was admitted to the hospital for evaluation, not

because of any respiratory complaints but rather because he wanted a change in his wheelchair. On admission the vital capacity was 250 cc., only 5 per cent of the expected normal capacity. This figure seems hardly sufficient to maintain adequate lung ventilation but, subjectively, the patient appeared to be comfortable. By alveolar carbon dioxide measurement he was found to be adequately ventilated. All respiratory muscles are weakened. The patient sits during most of the daytime. He supplements his breathing by rocking his body forward and backward. While in the hospital he was given a trial using the tank respirator at night and mouth-positive respiration during the day. He preferred to get along without either.

Limitations to Lung Movement

Movement of the lungs is not only dependent on the forceful contraction of the muscles of respiration but the structures must also be compliant or flexible. Decrease in flexibility may result from fibrous contracture of lung tissue or the intercostal spaces, from stiffening of the rib cage which may be due to arthritis, from malalignment caused by severe scoliosis, from loss of diaphragm elasticity associated with paralysis of that muscle, from abdominal distention, or from abdominal muscle spasm as may be seen in spinal cord injury.

When decrease in vital capacity is used as an index of the effect of limitation of the lung movement on breathing, it must be remembered that other factors likewise influence vital capacity and consequently complicate interpretation. In spite of this, measurements do become clinically significant in the light of the general clinical picture. This will be illustrated by the following case.

Case 5: I. C., a 15-year-old girl, was stricken with poliomyelitis at the age of 10. Upon hospitalization she was placed in a respirator because of the marked respiratory weakness. She gradually improved and in about six months became completely free of the respirator. About a year later she was discharged home and followed in the outpatient clinic. Although the patient showed definite scoliosis before discharge this was not serious; however, she wore a removable moulded body jacket. While she was home the scoliosis greatly increased in severity. It was decided to re-admit the patient to the hospital and treat the back vigorously with a corrective cylinder body cast. The rigid cast caused considerable respiratory interference. After four months of such treatment the cast cylinder had to be removed and the patient placed in a respirator because of a rather sudden onset of dyspnea. After seven more months of hospital care, during which time she was treated with a re-

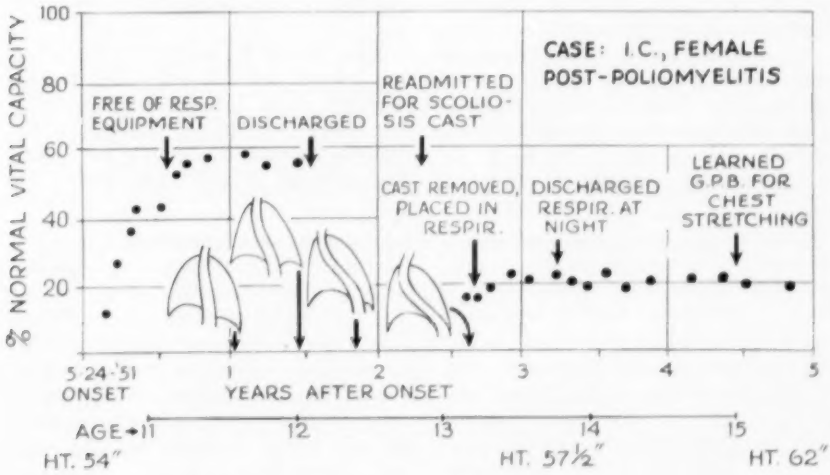

Fig. 3 — Effect of chest restriction on vital capacity.

movable and more flexible body support, she was discharged, this time being sent home with a tank respirator and also with the removable body jacket. The respirator was needed for respiratory assistance at night and also it was used for the purpose of maintaining chest mobility.

Figure 3 illustrates changes in the patient's vital capacity (per cent normal) during these events, and also corresponding changes in the scoliosis. The readings fell greatly at about the time that there was a marked increase in scoliosis. After a long period of instruction she learned glossopharyngeal breathing as an additional aid to chest stretching.

Distribution Pattern of Muscle Weakness

When the different muscles of respiration become uniformly weakened to a fraction of their normal strength, the vital capacity decrease would be expected to be a fairly reliable guide to the patient's expected breathing tolerance. There is also a decrease in the vital capacity when a portion of the respiratory muscles becomes weakened or paralyzed; but, in contrast to uniform weakness, the weakness or paralysis of one group of respiratory muscles may produce an entirely different breathing ability than when another group is involved, even though the vital capacities are the same. To illustrate, two contrasting cases are presented.

Cases 6 and 7: J. T., a 31-year-old man, and R. O., a 14-year-old boy, both became ill a year or more previously. They both have about the same per cent normal vital capacity. Case 6 (J. T.) has paralysis of essentially all respiratory muscles, except the neck accessory, and can breathe only three hours. Case 7 (R. O.) has paralysis of all respiratory muscles except the diaphragm and can breathe all day and all night (see table 3).

These two cases demonstrate the much greater efficiency of the diaphragm over the neck accessory muscles when used as the sole muscles of breathing. We have observed this in numerous instances and find that this is of great clinical significance. Obviously the pattern of respiratory muscle paralysis must be considered in interpreting vital capacity.

Body Position

In a normal person, vital capacity taken when the body is erect is only slightly greater than when supine. This is not true in the presence of certain patterns of muscular involvement. Thus, when only the abdominal muscles are paralyzed, the vital capacity is greater and breathing is easier in the supine position than in the erect. For diaphragm, chest, and neck paralysis this relationship is just opposite. Breathing is by the abdominal muscles and is in the expiratory reserve compartment. The effects of body position must be considered in interpreting vital capacity since knowledge of the breathing ability in the erect position is essential to proper rehabilitation planning. Again we shall illustrate by comparing two cases (table 4).

Cases 8 and 9: In Case 8, a 44-year-old woman, the deficiency is in the abdominal, chest, and diaphragm muscles, but when the body is supine, the diaphragm strength is adequate for breathing although it still lacks reserve for

Table 3: Effect of the Muscle Breathing Pattern on Breathing Ability in Two Patients

	Case 6 J. T.	Case 7 R. O.
Sex	Male	Male
Age, years	31	14
Years since onset	1	6
Vital capacity, cc.	825	600
Per cent normal	20	17
Breathing tolerance	3 hr.	Day and Night
Breathing pattern	Neck Accessory	Diaphragm

Table 4: Comparison of Vital Capacity and Breathing Patterns in Both Supine and Erect Body Positions

	Case 8 I. R.	Case 9 D. W.
Sex	Female	Male
Age, years	44	32
Time since onset	8 yr.	11 mo.
Respiratory muscle strength	Paralysis of abdomen and chest. Weakness of diaphragm and neck accessory muscles.	Paralysis of chest. Trace of diaphragm. Good abdominals. Fair neck.
Supine vital capacity	640 cc. — 20% normal	600 cc. — 15% normal
Supine breathing pattern	Weak diaphragm	Neck and abdominal muscles
Supine breathing tolerance*	12 hr.	45 min.
Sitting vital capacity	275 cc. — 9% normal	925 cc. — 23% normal
Sitting breathing pattern	Neck accessory	Abdominals
Sitting breathing tolerance*	3 hr.	12 hr.

*Observe the opposite effects on breathing tolerance as produced by the difference in involvement.

sleeping. While the patient is sitting, the weak neck muscles have to struggle to maintain lung ventilation since the diaphragm drops position and becomes ineffective. Tolerance breathing is limited to three hours. In Case 9, a 32-year-old man, the abdominal muscles are the only remaining strong respiratory muscles, and they act efficiently in the erect body position, but breathing supine is difficult — sleeping, impossible.

Diseases of the Heart and Lungs

Much has been written on the use of vital capacity in the interpretation of functional reserve in heart and lung disease. The combination of chronic heart or lung disease with disease that causes specific weakness of the respiratory muscles is relatively rare. When it does exist, the drop in vital capacity, which is due to both heart or lung disease and respiratory muscle weakness, gives a figure which is more or less an expression of the combined impairment, and the patient should be treated accordingly. Complicating atelectasis and pneumonitis, however, are common in patients with respiratory muscle weakness and the physician must be constantly alert to these conditions. When there is a drop in vital capacity, atelectasis is always a possibility, and such a finding may overrule a negative x-ray film when it is taken during the first 24 hours. On the other hand, x-ray evidence of atelectasis and pneumonitis may be present without a vital capacity drop.

Case 10: A. M., a 55-year-old woman, had pulmonary tuberculosis causing her to be hospitalized in a tuberculosis sanatorium 20 years ago. Treatment included thoracoplasty of the right chest 14 years ago. Before the time of onset of poliomyelitis in 1952, the tuberculosis was considered to be arrested and the patient's activities were essentially normal, consisting of ordinary housework. The acute phase of poliomyelitis appeared to be associated with quite severe weakness of the respiratory function and her vital capacity on discharge from the acute communicable disease unit was 800 cc., or 25 per cent normal. Stay at this hospital was characterized by a good return of function of the extremities and of the respiratory muscles. She was freed of respiratory equipment about four months after admission; however, her vital capacity fluctuated around a rather low value (1,000 cc., or 33 per cent normal). X-ray studies indicated obliteration of the right lung. On discharge there was no evidence of tuberculous activity. Upon return home her increased activity appeared to cause an activation of her tuberculous process and she had to be rehospitalized a year later. She was given respiratory aid and was transferred to a tuberculosis sanatorium two months later. Eight months later she was returned to this hospital, subjectively better, but still using the respirator at night, and was soon dis-

charged home. She was again re-admitted seven months later, now using the respirator continuously and showing a drop in vital capacity (875 cc.), and she was subjectively fatigued. She was again sent to a tuberculosis sanatorium from where she returned home after another year. She was re-admitted another time eight months later in respiratory distress and cyanotic. She had been using the respirator almost continuously. Vital capacity had dropped to 500 cc. After this she was again returned to the tuberculosis sanatorium where she now is.

In accord with our experience with other cases of pulmonary tuberculosis combined with poliomyelitis, it appears that more caution must be used in freeing the patient from respiratory aid than in uncomplicated poliomyelitic cases, and that the use of respiratory aid benefits the patient's status in regard to the tuberculous infection.

Case 11: L. J., a 36-year-old man became ill with poliomyelitis almost two years ago. During the acute stage he had to be placed in a respirator because of marked respiratory muscle weakness. About three weeks after onset of his illness he was admitted to this hospital with a vital capacity of 75 cc. (2 per cent normal). About seven months after admission, this capacity increased to almost 1,000 cc. (24 per cent normal). This vital capacity was due to chest, neck accessory, and abdominal muscle action; no more than a trace of diaphragm was evident. The vital capacity remained about the same for two months, at which time he had an episode of convulsions and coma. This was followed by massive atelectasis and clearing after treatment. Figure 4 shows these changes graphically.

Summary and Conclusion

The deficiency of respiratory reserve, as expressed in per cent normal vital capacity, is the integration of several factors, which may include any of the following: strength, endurance and adaptation, limitation of lung movement, distribution pattern of muscle weakness, body position, and presence of heart or lung disease, as well as certain technical factors. Before vital capacity measurements can be used to advantage as guides in treatment and in the prognosis of expected functional return, insight into all of these factors is necessary. If this is not done, vital capacity figures may be misleading.

We do not wish to give the impression that the significance of vital capacity is hopelessly complicated and that its use, therefore, is impractical. On the contrary, it is a very valuable clinical tool and when properly qualified it expresses in a quantitative objective way conditions of the patient that otherwise might be a matter of vague medical opinion.

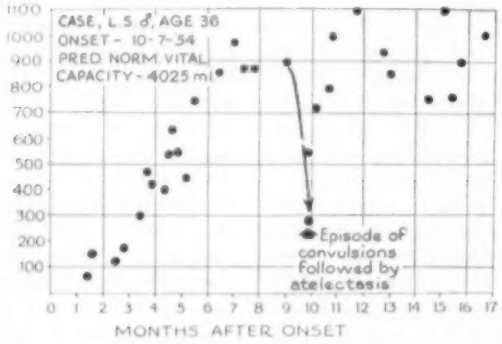
CASE, L. S. ♂, AGE 36
ONSET - 10-7-54
PRED. NORM. VITAL CAPACITY - 4025 ml
Episode of convulsions followed by atelectasis
MONTHS AFTER ONSET

Fig. 4 — Vital capacity changes associated with atelectasis.

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IMPORTANT ANNOUNCEMENT

The Editorial Board of the *ARCHIVES OF PHYSICAL MEDICINE AND REHABILITATION* has established a special subscription rate of $5.00 per year to be granted to bonafide residents in physical medicine and other specialties in the United States, its territorial possessions, Mexico, Canada, United Kingdom and Europe. The following rules apply:

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Problem of Home Treatment in Arthritis

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Leonard F. Bender, M.D.
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Patients with chronic diseases tend to lose interest in even the most carefully planned schedules of home treatment. This is a normal and natural tendency. The problem for all those involved in the care of the patient is how to counteract this natural tendency and to substitute for it a strong and purposeful drive. It is of basic importance that patients clearly understand what they must do and why they must do it. These are the aims of the program of instruction.

A review of the literature from 1940 to the present time yields little information about the best way to interest a patient and keep him interested in the project of treating himself for an ailment that he may have lived with for a long time. In 1943 a report from the Mayo Clinic[1] gave the results of a survey of arthritis patients chosen at random from several thousand clinic patients who had been instructed in home physical therapy. Of the 346 patients to whom the investigators sent a questionnaire, 216 responded. The results showed that 92.7 per cent had started the treatment program and 64.7 per cent had continued treatment for three months or more. There were 96 patients with rheumatoid arthritis in this group; 63.5 per cent of these were continuing home treatment or else had stopped because their condition had improved.

A survey of arthritis patients at University Hospital has recently been conducted in order to gain information that might help us evaluate our program of instruction in home treatment and shed some light on why patients continue or stop their home treatment schedules. For several years the medical arthritis service of this hospital has referred most of its patients to the Department of Physical Medicine and Rehabilitation for treatment and for instruction in home treatment as needed. In January, 1953, an outpatient arthritis clinic was established under the direction of the staff of the Rackham Arthritis Research Unit; participating in the clinic activities are residents in internal medicine, orthopedics, and physical medicine. During the past year a physical therapist has been present in the arthritis clinic to give individual instruction in home physical therapy as prescribed by the physicians. Periodic review and reinstruction are primary objectives of this arrangement. For the study reported here, 56 patients were interviewed during their visits to this arthritis clinic.

The recorded information included the age and sex of the patient, date of onset of the disease, medical treatment the patient had received, amount and type of instruction in home physical therapy, and length of time that the patient continued on a satisfactory home program. The American Rheumatism Association's designation for stage of disease and functional class[2] also was recorded for each rheumatoid arthritis patient. When questioning the patient regarding his faithfulness in continuing the home program, an attempt was made to assess each modality separately. Continuation of only a portion of the recommended program was not considered satisfactory home treatment.

In the group surveyed there were 18 male and 38 female patients ranging in age from 11 to 71 years. The age distribution by decades is recorded in table 1.

Of the 56 patients, 47 had rheumatoid arthritis, 7 had rheumatoid spondylitis, and 2 had osteoarthritis. The average duration of disease in the group was 9.9 years. All patients had been receiving acetylsalicylic acid or salicylates, 43 were

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Assistant Professor of Physical Medicine and Rehabilitation, University of Michigan Medical School.

Table 1: Age Distribution in Decades of 56 Arthritis Patients on Home Treatment Program

Age, Years	No. of Patients
10-19	1
20-29	7
30-39	9
40-49	17
50-59	13
60-69	6
Over 70	3

Table 2: Distribution of 47 Patients with Rheumatoid Arthritis According to Classification of the American Rheumatism Association

Stage of Disease	Functional Class I	II	III	IV
I	6	2	0	0
II	4	8	2	0
III	1	14	6	2
IV	0	0	1	0

receiving or had received corticosteroids in one form or another, and 39 were receiving or had received gold injections. Table 2 shows the stage of disease and the corresponding functional class for the 47 patients with rheumatoid arthritis.

Fifty-one of the patients had been instructed in a home program of physical therapy by a registered physical therapist carrying out the prescription of a physician in the arthritis clinic or in the Department of Physical Medicine and Rehabilitation. The remaining 5 patients had received instruction from physicians, either their own or a staff member in the arthritis clinic; 38 patients were instructed more than once. The results of the survey are shown in tables 3 and 4.

From table 3 it is seen that 6 patients never even started on their recommended home programs. Among the rest, 27 were still continuing adequate home treatment programs, but 18 who needed further home physical therapy were not treating themselves adequately. At the time of the interview, 5 patients had stopped their home program because their physical condition had improved significantly.

Of the 18 patients who stopped treatment before achieving the maximum benefit from it, 13 had stopped treatment within the first four months and 8 of these had stopped treatment between two and four months after they had received instruction (table 4). This was greater than the number stopping in any other comparable period of time.

One of the major objectives of this survey was to determine the factors that influence a patient to continue an adequate home treatment program. It seemed to us that the severity of the patient's rheumatoid involvement might well be an important influence; however, we were unable to establish any relationship between the severity or classification of the patient's rheumatoid involvement and the length of time he would follow home treatment. From the data obtained in the interviews with these 56 patients we found that approximately 55 per cent of the patients who were classified in each one of the four functional classes were continuing home treatment at the time of the interview or had stopped treatment because of significant improvement in their physical condition.

Another variable that could influence the length of time a patient continues home treatment is the number of initial instruction periods provided him. However, it appears from the information obtained in these 56 cases that the patients who are instructed in home treatment programs only once are just as likely to continue home treatment as are

Table 3: Distribution of 56 Arthritis Patients According to Continuation of Home Treatment Program

Elapsed Time from Instructions to Interview (Months)	No. of Patients	No. Starting Treatment	No. Continuing Treatment	No. Stopping Treatment: Not Improved	No. Stopping Treatment: Improved
Under 2	2	2	2		
2-6	7	7	5	2	
6-12	9	8	3	5	
12 or longer	38	33	17	11	5
Totals	56	50	27	18	5

Table 4: Duration of Home Treatment Program for 18 Patients Who Stopped Treatment Prematurely

Months Home Program Was Continued	No. of Patients
0-2	5
2-4	8
4-6	1
6-12	3
Over 12	1
Total	18

those who are instructed two or more times.

Moreover, it is evident that there will always be a small number of patients, represented in this study by the six, who will not follow directions at all. On the other hand, 57 per cent of the patients in this series were continuing an adequate home treatment program at the time of the interview. So we may hope that there will always be a rewarding number who will respond satisfactorily to adequate instruction and motivation. Therefore, the group that we are most interested in is the group of patients who stopped home treatment before they had obtained the maximum benefit from it. No relationship could be established between the severity of disease or number of initial instruction periods and the length of time that the patients pursued an adequate home treatment program. These 18 patients gave many reasons for stopping the programs. No specific cause for their apathy could be determined by this survey but there were indications that they needed more frequent encouragement, re-evaluation, and reinstruction.

Patients with other chronic diseases are re-evaluated and reinstructed periodically. The patient with arthritis should not be expected to carry out a complicated home treatment program for long periods of time unassisted. Careful reinstruction, including details of necessary changes in the program, must be given at frequent intervals. Our survey indicates that the home treatment program for the patient with arthritis should be reviewed with the patient at least every two months in order to maintain his interest and co-operation and to motivate him in his isolated campaign. We hope in this way to be able to increase the number of patients who follow adequate home treatment programs for the prolonged periods of time that are usually necessary.

Summary

In order to evaluate the effectiveness of instruction in home treatment programs a survey was conducted among patients with rheumatoid arthritis and osteoarthritis. Fifty-six patients who had previously been instructed in adequate home treatment programs were personally interviewed at length by one of us (LBP).

At the time of the interview, 5 patients had stopped their home treatment because of improvement in their condition. Of the remaining 51 patients, 27 were still continuing adequate home treatment programs, but 24 patients who needed physical therapy were not treating themselves adequately. Six of these 24 patients never started on their recommended home program; 8 stopped home treatment between two and four months after their instruction. This was greater than the number stopping in any other comparable period of time.

Therefore, it appears that the home treatment program for arthritis should be reviewed with the patient at least every two months. One expects to re-evaluate and reinstruct periodically patients with other chronic diseases. The patient with arthritis should not be expected to continue a complicated home program for long periods of time. Careful reinstruction including necessary additions to and deletions from the program of home therapy must be given at frequent intervals.

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Conservative Management of Certain Types of Back Injury: Analysis of Results

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and
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Dallas, Texas

This study was undertaken in an attempt to determine the efficacy of conservative management of acute low back injuries. Various factors influencing response to treatment, including the expectation of monetary compensation for the injury, were considered.

Clinical Material

Over 500 patients treated in the Physical Medicine Department of Baylor University Hospital during the past five years were used for the series. These patients were referred for physical therapy by practicing physicians, mostly orthopedic surgeons and neurosurgeons, who had done the initial work-up and established the diagnosis of acute low back pathosis. Many of the patients had already received some treatment, such as bed rest at home, elementary physical therapy, or back manipulation prior to referral.

The most common symptom was pain in the lower back, often with radiation into one leg and sometimes both legs. Many patients complained of back pain upon coughing or sneezing. Almost all the patients demonstrated some degree of limitation of straight leg raising. The majority did not exhibit any significant diminution of deep tendon reflexes. Many patients noted numbness to pinprick over portions of the lower extremities though this usually did not conform to dermatome distribution. Very few patients had true weakness of the dorsiflexors of the foot. Nearly all patients had limitation of back motion ranging from that noted only on testing to constant assumption of the flexed position. Only patients with an acute back strain, that is those who could relate the onset of symptoms to a particular incident, were included. No effort was made to exclude patients with the clinical diagnosis of possible ruptured intervertebral disc.

Selection of Cases

A minimum of five treatments was set by the authors for inclusion in the series for three reasons. First, they felt that patients who became symptom-free on fewer treatments might very well have improved without treatment. Secondly, the group receiving fewer than five treatments included many with obvious severe surgical lesions and therefore required more than conservative management. Lastly, patients who came to physical therapy less than five times provided a slim chance for any kind of follow-up.

Method of Treatment

Treatment consisted of 30 minutes of heat, usually furnished by short wave diathermy, unless contraindicated, and deep sedative massage as tolerated by the patient. Low back flexion exercises, beginning with pelvic tilt and head raising with the legs flexed and progressing to one-leg and two-leg low back stretching, were added to the program once the patient had passed the very acute stage. In addition, the majority of the hospitalized patients were at bed rest in the jackknife position, with or without leg traction, and many received muscle relaxants.

Distribution of Patients

The 509 patients included in the study were grouped into those with a compensable injury and those without a compensation factor and then further

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Table 1: Distribution of Patients

Type of Patient	No. of Patients	Percentage
Compensation male	213	42
Compensation female	59	12
Noncompensation male	116	22.8
Noncompensation female	121	23.2
Total	509	100.0

divided according to sex (table 1); 54 per cent of the patients were eligible for compensation and 46 per cent were not. As might be expected, there were very many more men than women in the compensation group. The noncompensation patients were about evenly distributed with regard to sex.

Outline of Study

The patients were studied with regard to the duration of complaints before treatment, improvement following treatment, the relationship of the duration of symptoms before treatment to the results of treatment, the number of treatments received, hospitalization, and the results of treatment at late follow-up.

Results

Duration of Complaint Before Treatment: It was found that over two thirds of the noncompensation patients, both male and female, had appeared for treatment during the first month of symptoms, whereas only about half of the compensation patients had been seen at this point. Less than one tenth of the noncompensation patients were referred for physical therapy after more than three months of complaints, but about one fifth of the compensation patients came for treatment over three months after their injury (fig. 1).

Results of Treatment: The results of treatment were classified as either improved or unimproved, largely on subjective grounds. A patient was considered unimproved if he or she continued to complain and failed to resume normal activities, including work, regardless of objective improvement. Figure 2 shows improvement for the compensation and noncompensation patients as a whole and also when divided according to sex. Only 55.8 per cent of the compensation patients were rated improved at discharge from the physical medicine department as compared to 88.5 per cent improvement in the noncompensation group. The observed difference in improvement between men anticipating compensation and those who did not was 27.2 per cent, while the statistical difference to be expected on the basis of chance is only 9.6 per cent. For the women the observed difference was 38.3 per cent, with a statistical probability of 13.8 per cent.

Correlation of Results With Duration of Symptoms: The results of treatment were correlated with the duration of symptoms before physical therapy was started. Figure 3 shows the percentage of patients improved for different durations of complaint for compensation and noncompensation patients. Though the

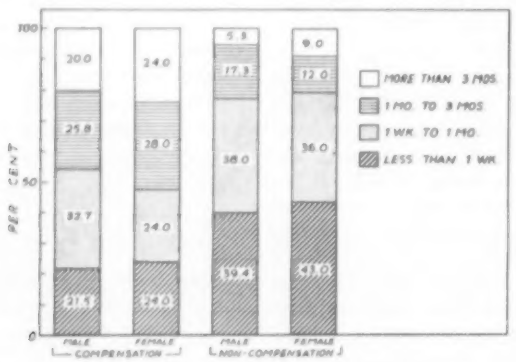

Fig. 1 — Duration of complaint before treatment.

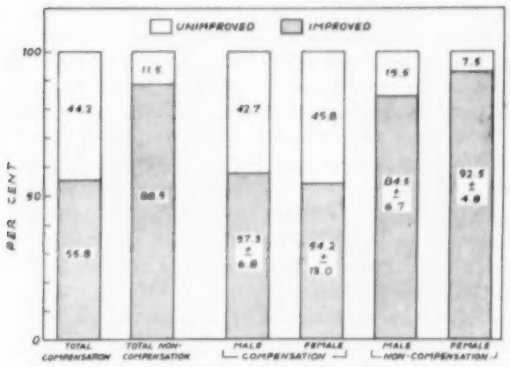

Fig. 2 — Results of treatment.

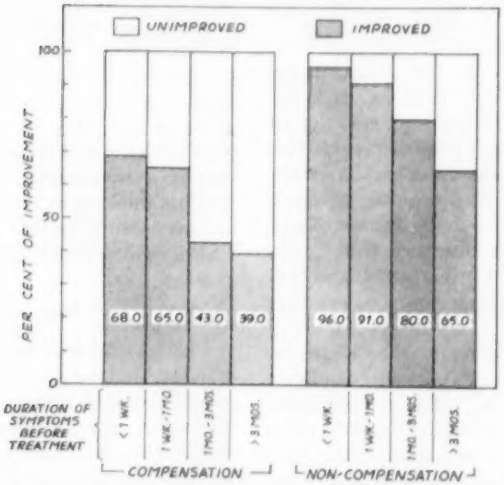

Fig. 3 — Correlation of results of treatment with duration of symptoms.

Table 2: Number of Treatments Received

Type of Patient	Mean Number of Treatments	Observed Difference in Mean Number of Treatments	Statistical Probability
Compensation male	18 ± 1.9		
		8	2.2
Noncompensation male	9.8 ± 1.1		
Compensation female	18.3 ± 3.7		
		7	3.9
Noncompensation female	11.1 ± 1.3		

Table 3: Late Follow-up of Patients

	Compensation Male	Compensation Female	Noncompensation Male	Noncompensation Female
Percentage in late follow-up	53	66	64	61
Percentage of late follow-up to surgery	21.6	11.1	14.2	12.1
Percentage of late follow-up improved	44.2		91.1	
Percentage of immediate follow-up improved	55.8		88.5	

compensation patients exhibit less favorable results throughout than the noncompensation patients, both groups show a definite decrease in the number improved among the patients appearing for treatment after more than one month of symptoms. This is especially marked in the compensation group.

Number of Treatments Received: The number of treatments that the patients received varied from the arbitrary minimum of 5 to 91. The mean number of treatments was calculated for each of the four groups and is given in Table 2. There was a striking similarity between the mean values for men (18) and women (18.3) in the compensation group and between those for men (9.8) and women (11.1) in the noncompensation group. As can be seen, both the male compensation patients and the female compensation patients received a significantly greater number of treatments than did their noncompensation counterparts. Over half the compensation patients were dismissed from physical therapy after 13 treatments, and over half the noncompensation patients after 9 treatments.

An attempt was made to correlate the number of treatments with improvement. Unfortunately, no definite correlation was possible. The mean number of treatments for improved patients essentially did not differ from either the mean number of treatments for the unimproved patients in the same group or the mean number of treatments for the group as a whole.

It was also attempted to correlate the mean number of treatments with the duration of symptoms before treatment was started. Figure 4 depicts a definite relationship in the compensation group where those who waited the longest before treatment received the greatest number of treatments. There probably is no definite correlation in the noncompensation group — the apparently greater number of treatments for those who have had symptoms more than three months might not be significant because of the small number of patients in this group.

Hospitalization: One might expect that more compensation patients would receive hospitalization than noncompensation patients; however, it was found that 73 per cent of the compensation patients were hospitalized and 76 per cent of the noncompensation patients were also hospitalized. The compensation patients spent an average of four more days in the hospital than did the noncompensation patients. This difference was statistically significant for the men but not for the women.

Late Follow-Up of Patients: A late follow-up was obtained from the records of the referring doctor for 358 of the patients in the series (table 3). The time covered by this follow-up varied from a few weeks to several years after dismissal from physical therapy. The evaluation of the referring physician either upon discharge of the patient or upon his last office visit was used as the final result. When patients who had surgery were excluded, the percentage of patients showing long-term improvement was very similar to that shown originally. This is depicted in figure 5.

Discussion

Though the literature contains much material about the various causes of back pain, numerous descriptions of patients' symptoms, and various schemes of treatment, there is a very real dearth of information concerning the results of treatment. In fact, a perusal of the recent literature revealed no analyses of authors' results of treatment in terms of number of treatments or factors affecting treatment. Thus, the present study was undertaken to provide such an evaluation.

The evaluation of patients as improved or unimproved on the basis of their symptoms seemed logical because objective improvement is of little value if the patient is having too much pain to return to work. This method is not without precedent, having been used by Coyer and Curwen,[1] Jessup and coworkers,[2] Breck and Palafox,[3] Haggart and Graunis,[4] and R. N. Wilson and S. Wilson[5] in their studies of the management of low back pain.

Our results of 88.5 per cent improved among the noncompensation patients are very similar to those of Coyer and

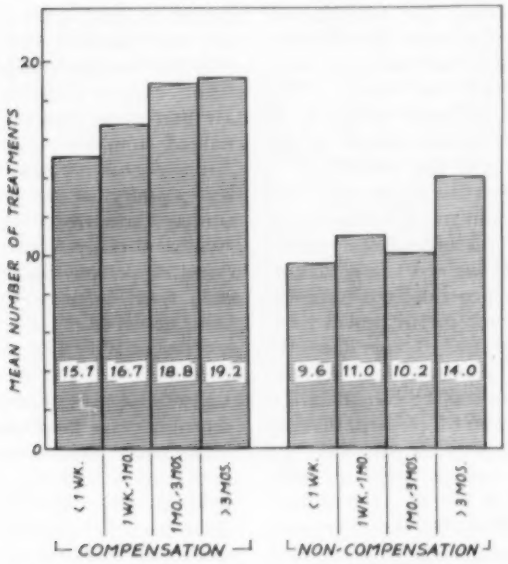

Fig. 4 — Correlation of duration of symptoms with number of treatments.

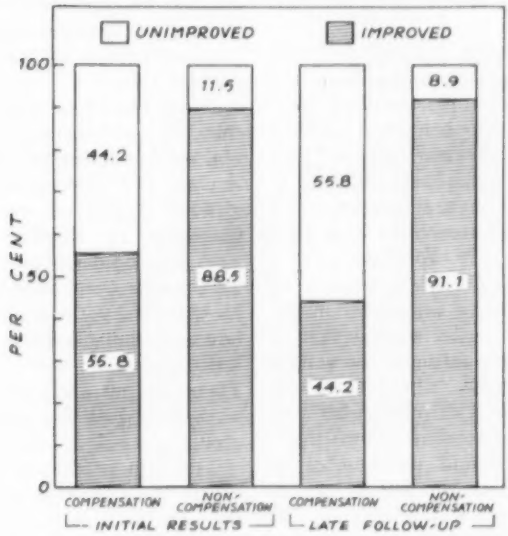

Fig. 5 — Comparison of results of treatment at immediate follow-up and at late follow-up.

Curwen[1] who reported 88 per cent of their patients improved, Breck and Palafox[3] with 87 per cent of patients improved, and Haggart and Graunis[4] who had 91 per cent patient improvement. The improvement of compensation patients of 55.8 per cent was far different from that of 87 per cent reported by Jessup and co-workers.[2] However, his patients were all ambulatory and were treated at work, while three-fourths of the patients in the present series were hospitalized, which reflects a probable difference in extent of injury.

If hospitalization can be taken as an index of the severity of the symptoms, and thus the severity of the injury, essentially no difference exists between compensation and noncompensation patients in this regard in this series. As

previously mentioned, the majority of patients in the study were hospitalized. This would seem to indicate that most of the injuries were not trivial. This series has probably been weighted in favor of the more serious injuries by the imposed minimum of five treatments.

Results show that the longer a patient waits before treatment, the smaller is the possibility of his improving, regardless of whether he expects compensation or not, and that generally the compensation patients come for treatment later in the course of their disease than do noncompensation patients. However, the fact remains that even the compensation patients that are seen for physical therapy during the first week after injury do not do as well as noncompensation patients seen three or more months after injury. Thus, though patients in general respond better to treatment when it is initiated early, this factor alone was not the key to the recalcitrant symptoms of the compensation patient.

The compensation patients received significantly more treatments than did the noncompensation patients. Of course, most of the noncompensation patients were paying for their treatments and may have found it economically difficult to continue formal physical therapy once they were able to return to their employment. However, it appears that it actually requires a greater number of treatments to bring a compensation patient's symptoms under control than it does to accomplish as much for a noncompensation patient.

While there was a correlation between the duration of symptoms before treatment was started and the number of treatments received for the compensation group, no such relationship appears to be present in the noncompensation group. We feel that this indicates the deleterious effects of prolonged pain and time lost from work on the patient's psychological outlook. For, under these conditions, many patients become extremely resentful of their employers or their doctors or both and lose their motivation to return to work.

In the analysis of the number of treatments received by patients, the authors were unable to delineate the optimal number of treatments since no correlation was possible between results of treatment and the number of treatments given. This is probably related to the fact that many patients had to be discharged from the hospital by their referring doctor because of certain other factors and thus not necessarily at the optimal time from the standpoint of physical therapy. Some patients continued simple physical therapy at home or in their doctor's office.

For this reason a long-term follow-up was undertaken. The percentages of patients improved, both in the compensation and in the noncompensation groups, were surprisingly like those observed upon discharge from physical therapy. Thus it appears that one could safely recommend an early settlement, with provision for surgery if it be needed, since the passage of time does not improve the results of formal physical therapy in the majority of patients. It was gratifying to note that patients who improve with physical therapy will rarely relapse without reinjury.

It was interesting that throughout this study the woman expecting compensation for her injury has shown the worst response to treatment while receiving the greatest number of treatments. In his discussion of Haggert and Graunis' work,[4] Alexander Aitken noted this same unfavorable trend in the women among his industrial patients who underwent intervertebral disc surgery — out of 36 such women, only 4 ever returned to work. These patients are truly discouraging to work with, both as individuals and as a group.

The authors feel that, considered as a group, the compensation patient suffering an acute back strain is different from the noncompensation patient even though his injury is the same. Yet some compensation patients respond well to conservative treatment and return to their jobs after a minimum number of treatments. The difficulty would appear to lie within the basic personality structure of the individual receiving the injury. For some patients a back injury seems to represent a way of "getting back" at the employer. Once a cash settlement is made the back pain and disability often

rapidly subside. However, with very rare exceptions, these patients are not malingering; rather they seem to be suffering from a sort of compensation neurosis. Lacking facilities for formal psychotherapy, the authors have attempted to work around this neurosis through their approach to the patients. This consisted of maintaining from the outset that the patient's back disability is only temporary and of recommending early settlement of his case as suggested by Fetterman[6] and Jones.[7] This method unfortunately leaves much to be desired.

The compensable back injury is such a common occurrence and its economic implications are so far-reaching that there is a real need for further investigation. For the present the following suggestions may be of value: the employer should make an effort to provide early adequate conservative treatment; the insurance company should maintain a co-operative attitude toward a patient's treatment program; litigation should be avoided if possible, for the engaging of a lawyer often seriously retards the patient's recovery; and the physician should encourage an early settlement.

Summary

Five-hundred nine cases of acute low back strain treated by conservative means were analyzed. These cases were studied with regard to compensable injury, duration of symptoms before treatment, the relationship of duration of symptoms before treatment to the results of treatment, the number of treatments received, and the results of treatment at late follow-up. Compensation patients were referred for treatment longer after their injury than were noncompensation patients. Eighty-eight per cent of the noncompensation patients improved with treatment as compared to only 55.8 per cent of the compensation patients. There was a correlation between the duration of symptoms before treatment and lack of improvement. Compensation patients received a significantly greater number of treatments than did noncompensation patients, although hospitalization was similar for both groups. Results of treatment at late follow-up were very nearly the same as those at discharge from physical therapy.

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THE SCIENTISTS' COMMITTEE ON SECURITY

Formed in January of 1956 to act as a clearinghouse for information and responsible scientific opinion on matters of information security and personnel security; to undertake, from time to time, special studies of particular, important issues of science and security and to prepare and make public appropriate reports; to cooperate with and to assist government agencies in establishing and maintaining realistic security programs which safeguard both the long-range security of the United States and the traditional rights of its citizens; to stimulate constructive thought on questions of information security and personnel security; to foster a better popular understanding of the true relationship of science and security.

IMPORTANT NOTICE TO CONGRESS MEMBERS

Please take notice that at the last annual business meetings of the American Congress of Physical Medicine and Rehabilitation, September 11 and September 13, 1956, The Ambassador, Atlantic City, N. J., the following amendments to the Constitution were presented in writing. These amendments will be presented to the general membership for acceptance or rejection at the annual meeting, Hotel Statler, Los Angeles, September 8-13, 1957.

ARTICLE III — MEMBERSHIP

Section 1 — Classes of Members — This organization consists of:

(a) Active members

(b) Associate members

(c) Honorary members

Amend Article III, Section 1, to read as follows:

This organization consists of

(a) Active members

(b) Associate members

(c) Honorary members

(d) Affiliate members

Section 2 — Qualifications — The qualifications stated below with respect to each class of membership noted are prerequisites for eligibility for the class stated:

(a) To be an Active Member a person must be:

(1) A graduate in medicine and surgery, legally qualified to practice medicine and surgery in some state or territory, or in the District of Columbia or in some foreign country and, unless a foreign resident, be either (a) a member in good standing in a local medical society which is a component society of the American Medical Association or (b) be a medical officer in one of the Federal Services.

(2) Elected to such membership in accordance with the applicable provisions of the By-Laws.

(b) To be an Associate Member, a person shall be a physiologist, physicist, biophysicist, electrical engineer, mechanical engineer, chemical engineer, research worker, investigator, teacher or any other expert in the field of physical medicine and rehabilitation and shall be invited by the Membership Committee.

(c) To be an Honorary Member a person shall be an eminent person interested in physical medicine and rehabilitation and shall be invited by the Membership Committee, or shall be a holder of the Gold Key.

Amend Article III, Section 2, to read as follows:

(a) To be an Active Member a person must be:

(1) A graduate in medicine and surgery, legally qualified to practice medicine and surgery in some state or territory, or in the District of Columbia or in some foreign country.

(2) Elected to such membership in accordance with the applicable provisions of the By-Laws.

(b) To be an Associate Member, a person shall be a physiologist, physicist, biophysicist, electrical engineer, mechanical engineer, chemical engineer, research worker, investigator, teacher or any other expert in the field of physical medicine and rehabilitation and shall be invited by the Membership Committee.

(c) To be an Honorary Member a person shall be an eminent person interested in physical medicine and rehabilitation and shall be invited by the Membership Committee, or shall be a holder of the Gold Key.

(d) To be an Affiliate Member, a person shall be actively enrolled in an approved residency or fellowship in Physical Medicine and Rehabilitation.

These amendments were submitted in accordance with Article XVI — Amendments of the Constitution which reads as follows:

"This Constitution may be amended in whole or in part at any annual business meeting by a two-thirds vote of all voting members present and voting provided that prior to that time the amendment —

(1) Has been presented in writing at the previous annual business meeting, and

(2) A copy of the proposed amendment, together with a notice that the matter will be voted on is sent by mail to each member or is published in the ARCHIVES OF PHYSICAL MEDICINE AND REHABILITATION not less than one month in advance of the annual business meeting at which action is to be taken."

In 1781 it was El Pueblo de Nuestra Senora La Reina de Los Angeles de Porciuncula . . . **In 1957 it is Los Angeles!**

At first sight, the visitor is awed by the vast size of Los Angeles. Inevitably, it is the forward-moving tempo of Los Angeles and its citizens that creates the most lasting impression.

Modern Los Angeles is a city bulging with muscle; vibrating with confidence and enthusiasm; always looking ahead to things that must be accomplished in the future. Record-breaking performances in agriculture, industry, population increase, construction and production are ordinary events in the day-to-day life of this metropolis. In its infancy, less than a century ago, Los Angeles was an outpost isolated from the "civilized world" by deserts, mountains and ocean.

In the face of these harsh realities, the creativity for which Los Angeles has become famous manifested itself. With vision, imagination and boundless energy, early Angelenos set to work to find solutions for these seemingly insurmountable problems. Eventually, from the Owens Valley, they brought water across 250 miles of desert through the world's longest aqueduct. A mud flat 24 miles from the heart of the city was transformed into one of the nation's greatest harbors. With the additional blessing of fertile soil and a refreshingly gentle climate, early residents brought forth riches of oil, minerals, fruits and vegetables in such abundance that people flocked from all parts of the country to see the wonders of this "Golden Garden."

With 11 accredited colleges and universities in the area, Los Angeles has achieved national stature in the field of education. The small pueblo of a hundred years ago has become the focal point of culture and the arts in the country, and the number of its prominent men of letters compares favorably with any city in the world.

Today's visitors to this metropolis are never at a loss for something to do or some place to go for amusement, enlightenment or ordinary sightseeing.

Glamorous Hollywood, that indefinable area which has an outward appearance much the same as any other part of Los Angeles, is a tourist "must." Movie studios are scattered from Culver City through Hollywood proper to the San Fernando Valley, but the glitter and "make believe" of the movie-making world permeate the film capital stores, restaurants, theaters and even the appearance of its inhabitants.

High on the visitors list of things to do is a visit to one of the major radio or television studios, with attendance at one or more broadcasts. Many of the nation's top programs originate in Los Angeles.

There are many points of historical interest and scenic beauty which enhance the attractiveness of Los Angeles. There is Olvera Street, a bit of Old Mexico with curio shops and cafes. Chinatown, with its quaint shops, lily pools and courts, offers silks, antiques, jewelry, and scores of other souvenirs. Grauman's Chinese Theater, a landmark of Hollywood Boulevard, is famous for its courtyard, in which appear the hand and foot prints of movie stars, past and present. Those interested in a different variety of stars will find the Griffith Park Observatory of special note.

Other scenic attractions include the San Fernando Valley with its "outdoor life" homes and suburban gardens, Santa Catalina Island renowned for its submarine gardens and Mediterranean atmosphere, the world-famous Los Angeles and Long Beach Harbors, and the impressive Palisades overlooking the beach at Santa Monica.

Year-round outdoor living becomes a reality as the visitor wanders through Farmers' Market trying to decide which of the varied and interesting outdoor restaurants strikes his fancy. This is indeed a unique shopping center for food, gifts, clothing and novelties from all parts of the world.

Children everywhere have been thrilled by the fabulous new Disneyland. This fairyland in concrete and steel brings to life such legendary characters as Mickey Mouse and Donald Duck and provides everyone, adults and youngsters alike, with the opportunity of taking a rocket-trip to the moon.

The Old West and the days of the '49ers live again in the authentic atmosphere of Knott's Berry Farm and Ghost Town. What was begun in 1920 as a small berry shed has become today a nationally recognized "must" as a tourist attraction.

Jules Verne's undersea world comes into sharp focus at the new Marineland aquarium, the world's largest oceanarium. Visitors by the thousands flock to this magnificent creation of modern science, where every conceivable type of ocean habitat has been duplicated.

Come and See!

book reviews

The reviews here published have been prepared by competent authorities and do not necessarily represent the opinions of the American Congress of Physical Medicine and Rehabilitation and/or the American Academy of Physical Medicine and Rehabilitation.

PRINCIPLES OF CLINICAL ELECTROCARDIOGRAPHY. By *Mervin J. Goldman*, M.D. Paper. Price, $4.50. Pp. 310, with illustrations. Lange Medical Publications, PO Box 1215, Los Altos, Calif., 1956.

This book was written for students and medical practitioners who might be interested in deepening their understanding of the principles of electrocardiology. To this end, they have achieved a book which is easily understood. Each step is illustrated by an artist's conceptual drawings or by actual reproductions of electrocardiograms.

The text is not written in highly technical terminology but is clinically professional. Debate or controversy is mentioned but not elaborated. The references, which are few, are listed on the last page. For one who is trying to familiarize himself with frequent ECG interpretations, this is a good and handy book. For the finer points of expert interpretation and theory, the student will have to look elsewhere.

It is a well-organized body of material with a good format. The reviewer would criticize the small type used but that may only be a confession that his arms are getting too short.

ORTHOPADISCHE GYMNASTIK. By Prof. Dr. Med. *Georg Hohmann* and *Lina Jegel-Stumpf*. Paper. Price, $4.65. Pp. 138, with illustrations. Georg Thieme Verlag, 14a, Stuttgart, Germany, 1956.

Richly illustrated with photographs and diagrams, this book is a mine of ideas for anyone working in corrective gymnastics. The approach is the practical one of picturing the intended activity, setting the stage so that the patient almost automatically does the right thing, and giving little stanzas for young patients to recite while learning the rhythm. The major divisions of the book deal with the round back, lordosis, the flat back, scoliosis, and malfunction (especially paralyses and contractures) in the extremeties. The present edition contains new material on posture with exercises for inculcating desirable habits. The bibliography affords a key to European contributions published since the second edition of this book appeared in 1948. Because of the instructive illustrations, the book can be recommended to the attention even of those who cannot read the text.

TRAINING OF THE LOWER EXTREMITY AMPUTEE. By *Donald Kerr*, B.B.A., and *Signe Brunnstrom*, M.A. Cloth. Price, $6.50. Pp. 272, with illustrations. Charles C Thomas, Publisher, 301-327 E. Lawrence Ave., Springfield, Ill., 1956.

This presentation fills a large gap concerning every-day practical methods of handling the lower extremity amputee. It is aimed not at one specific discipline concerned in the management, but actually at all groups involved; surgeon, therapist, limb maker and patient himself. The language, therefore, is minimally technical and easily understood by any reader. Enhancing the value of the book are many features not available in more technical treatises on this subject. There is an excellent analysis of faulty gaits and suggestions for correction. Exercises are lucidly presented and supplemented by illuminating figures. Special treatment has been given to training in daily activities; the methods described are of a progressively graded character so that the beginner is rightly distinguished from the more advanced trainee. Helpful points are emphasized in respect to fit and alignment of the prosthesis so that even the wearer becomes a more intelligent and critical observer in the process of restoration of function.

Some of the goals would appear to be unrealistic but this fault may be laid to the great enthusiasm and experience of the authors. Particularly for older people, certain training methods sacrifice safety for satisfaction in physical accomplishments. Certain of the exercises and daily activities suggested would appear doubtful of achievement in any but the young and athletically endowed.

These remarks however, are not intended to detract from the great value of the book. It will undoubtedly be useful as a reference and guide for physiatrists and physical therapists. There are many sections which should well become a sort of laboratory manual in the step by step training of the lower limb amputee. This latter use of the book will fill a great need, as too often one sees even in the restorative gymnasium a hit and miss approach to the management of the amputee.

THE STRESS OF LIFE. By *Hans Selye*. Cloth. Price, $5.95. Pp. 324, with illustrations. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 35, 1956.

Doctor Hans Selye is a physician-scientist who has yet to be evaluated in history. There will certainly be few who will receive greater respect or higher honor. In this book, the author collects the salient points from his observations on stress and shares again with all of us the story of a dedicated and purposeful existence. The book is stimulating, sometimes entertaining, but never light reading.

The author discusses what is known about stress and how he went about establishing the universality of the facts that he describes.

The story is presented under the following headings: discovery of stress, dissection of stress, diseases of adaptation, sketch for a unified theory, implications and applications. The book may be read profitably by anyone who is interested in anything.

Medicine, today, demands a knowledge of Selye's ideas of stress. The physician and student cannot absorb the concept in a more adequate or comfortable manner than by careful study of this volume. The book is well arranged. There are some photographs and diagrams. The high standard of excellence in writing for which Dr. Selye is known is maintained in this work.

THE IMAGE OF THE HEART. And the Principles of Synergy in the Human Mind. By *Daniel E. Schneider*, M.D., Cloth. Price, $6.00. Pp. 267. International Universities Press, Inc., 227 W. 13th St., New York 11, 1956.

The author presents rather curiously novel ideas and experiences in the psychosomatic approach to the interpretation of cardiac conditions. He holds that "except for certain relatively rare exceptions of congenital, inherited or infectious arteriolar disease, premature coronary death in relatively young men is the result of a most severe, though masked, continuous onslaught against the child and the image of the heart from six years of age onward." These patients exhibit some or all of the following traits — controlled tension, hurry and hurrying gait, constant need for self-purification or immunity, healed split ideas giving rise to partial transvestite impulses which are utterly concealed and denied and the final dyssynergic attribute that is the denial or destruction of his inborn talent. The author then unfolds further his new theory which he tries to justify as a new transformational science of synergic psychoneurology designed to bridge the gap between psychoanalysis and neurology.

The book is unique in presenting certain psychiatric concepts and could be of value to psychiatrists and some physiatrists who are devoting their time to psychiatric rehabilitation.

NEW BASES OF ELECTROCARDIOGRAPHY. By *Demetrio Sodi-Pallares*, M.D., and *Royall M. Calder*, M.D. Cloth. Price, $18.50. Pp. 727, with 520 illustrations. The C. V. Mosby Company, 3207 Washington Blvd., St. Louis 3, 1956.

This is the English edition of a book which had its third edition as a Spanish publication about 1951. As the author relates, in the preface, "present day electrocardiography rests on three fundamental pillars — the works of Willem Einthoven, Sir Thomas Lewis and Frank N. Wilson." Of more interest is the fact that scientific bases of this "new electrocardiography" and the physical and mathematical laws that have been drawn from the theories are not recently discovered bases or laws. They have been known for a long time, some even before the discovery of the string galvanometer. However, the application of these laws to the study of electrocardiograph tracings, has been used only the past few years.

This is not a book from which the clinician may learn the technic of electrocardiography, but rather the fundamental foundation of electrophysiology from which he may learn the basic meaning of the actual performance of cardiac tissue. With this type of basic knowledge, interpretation becomes factual information rather than an empirical diagnostic procedure. A thorough understanding of these new bases, should give a better, more sound clinical value to the diagnosis referrable to some heart disease and would lead to less iatrogenic heart disease.

The author has started with the dipole theory of the electrical response to the transmission of an impulse. He has then woven all variations of conduction of impulses about a single theory, primarily as it relates to cardiac conduction. He has had to make some assumptions the major one being that the body is a homogenous volume conductor. Except for occasionally adding further minor assumptions, such as the indifferent electrode being a representative of infinity, the basic concept holds for practically all the explanations of electrocardiographic findings.

The book is a profound study in which physical and mathematical criteria and facts are used to support each step in the development of the basis for potential changes caused by conduction or altered conduction in cardiac impulse transmission. It is a masterpiece which would have advanced electrocardiography by 40 or 50 years had all these theories been brought together at the time Einthoven first developed the principles upon which this clinical science grew.

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physical medicine abstracts

Kyphoscoliosis and Pregnancy. R. J. Dugan, and M. E. Black. Am. J. Obst. & Gynec. **73**:89 (Jan.) 1957.

The authors report on a series of 22 maternity patients with kyphoscoliotic involvement who were selected from a group of 84 cases with spinal deformities. The 66 cases not used were deformities of lesser degree without severe thoracic involvement. The number of pregnancies over a period of 6 years totaled 39. The age ranges of the 22 women studied were from 20 to 40 years.

Pulmonary function studies carried out on the patients revealed, in general, a decrease of approximately 50 per cent in the total lung volume as compared to a group of normals. Vital capacity was approximately 44 per cent of the total lung volume in the kyphoscoliotic as compared to 63 per cent in the normal. One patient who did not survive her third pregnancy was noted to have a vital capacity of only 600 cc. Except for five cesarean sections, all deliveries were uncomplicated.

The authors therefore feel that respiratory and cardiac embarrassment are the chief hazards associated with pregnancy in the kyphoscoliotic. A more detailed study regarding the exact degree of bony involvement and concomitant respiratory deficiency would have added to the scientific and clinical value of this paper.

The Aged Shoulder. S. M. Albert; D. M. Sklaroff; A. M. Rechtman, and H. Schraer. Geriatrics **11**:343 (Aug.) 1956.

The shoulders of 80 women and 45 men inmates of a nursing home were studied in respect to calcification, pain, range of motion, and history of hard physical labor and trauma. The average age was 80.1 years.

Fifty-five of 250 (22 per cent) shoulders revealed calcific deposit in the rotator cuff. Forty-one were in women and 14 in men. In 18 of 35 (50 per cent) patients with unilateral involvement, calcification was on the dominant side. In 22 of 38 (58 per cent) people doing heavy work, with calcification in one or both shoulders, calcification was on the dominant side. In 7 of 17 (41 per cent) doing light work, calcification was on the dominant side.

Nine of the 55 (16 per cent) shoulders with calcification were painful. Fifteen of them (27 per cent) had other degenerative changes but were pain-free. Sixteen of the 195 (8 per cent) shoulders without calcific deposit were painful. Of the 16, 6 had degenerative change in the acromioclavicular joint, 5 in the area of the greater tuberosity, 2 in the region around the acromion and 3 in the shoulder joint itself. Forty-six of the 195 (24 per cent) non-calcified shoulders, however, showed similar x-ray changes but were pain-free. Seventeen of the 195 (8 per cent) non-calcified shoulders were otherwise roentgenographically negative but painful.

Grating on motion was noted in 19 of 55 (35 per cent) calcified shoulders and in 65 of 195 (33 per cent) shoulders without deposit. In the calcified group restricted range of motion in flexion and internal rotation was present in 24 (43 per cent). Limitation was present in 90 (46 per cent) of the non-calcified group. Furthermore, motion was better on the calcified side in 21 (60 per cent) and on the non-calcified side in 6 (17 per cent) of 35 patients with a unilateral deposit. In 8 (23 per cent), there was no difference.

Five of 26 (19 per cent) patients with a history of acute trauma had calcific deposits. This was too small a series from which to draw conclusions. The authors conclude that calcification is greater with advancing age, is more frequent among women, is not correlated with pain, does not adversely affect joint motion and is not related to heavy labor.

Hypoxia at Normal Atmospheric Pressure as a Cause of Congenital Malformations in Mice. Francis J. Curley, and Theodore H. Ingalls. Proc. Soc. Exper. Biol. & Med. **94**:87 (Jan.) 1957.

Exposure of twelve pregnant female mice on the tenth day of pregnancy for two hours to a 6 per cent oxygen-94 per cent nitrogen mixture at normal atmospheric pressure (760 mm. of mercury) resulted in malformations of the kind found after exposure to a low atmospheric pressure (226 mm. of mercury), which in respect to the number of oxygen molecules per unit volume of air is the equivalent of 6 per cent oxygen in nitrogen at sea level. Humidity was not standardized in the bell jar in which the animals were exposed. Carbon dioxide concentration as measured by a Hay's gas analyzer never reached a measurable level. Oxygen concentration remained at 6 per cent. The authors do not mention temperature in the bell jar but presumably it was normal room temperature. Hemivertebrae, ablations and fusions of ribs and verte-

brae, and hypoplastic ribs were found in 26 per cent (15 of 57) of the progeny of the twelve females. None of the 52 progeny of the 10 control animals in ordinary atmosphere at sea level showed similar defects. The authors conclude that the malformations were late manifestations of hypoxia.

Importance of Flexion in Cervical Traction for Radiculitis. B. J. Crue, Jr. U. S. Armed Forces M. J. **8**:374 (Mar.) 1957.

When cervical traction is applied by heavy pull with the patient in a sitting position, most of the force is applied by the strap under the chin. Pull under the chin almost invariably leads to a considerable degree of extension of the neck. The vertical diameter of a C5-C6 vertebral foramen on an oblique cervical roentgenogram with the neck extended 10 degrees in a normal person was measured as 11.5 mm. The same measurement made with the person's neck flexed about 20 degrees was 13 mm. It is found that patients with cervical radiculitis symptoms experience relief of the symptoms with traction applied with the neck in flexion, whereas the symptoms are not relieved by traction with the neck in slight extension.

The Rocking Bed and Head Position. T. H. Joos; D. G. Dickinson; N. S. Talner, and J. L. Wilson. New England J. Med. **255**:1089 (Dec. 6) 1956.

Tidal air exchanges of eleven patients were measured on rocking beds with their heads in different positions. The three positions studied were: with the head and upper body in a straight line with rest of the body supine; the head and trunk elevated 15 degrees, and the head and trunk elevated 30 degrees. In the last two positions the head did not go below the horizontal plane when the bed was rocked. In seven of the patients at 15 degrees and in eight of the patients at 30 degrees, there was greater tidal air exchange than there was when the head was not elevated. It is recommended that patients who do not receive enough respiratory aid from a flat rocking bed be given a trial with the upper part of the bed elevated to 15 degrees or 30 degrees.

Nature of Pulmonary Damage Produced by High Oxygen Pressures. Kenneth E. Penrod. J. Appl. Physiol. **9**:1 (July) 1956.

Rats, guinea pigs, rabbits and cats were exposed to oxygen pressures up to 75 pounds per square inch for varying periods of time. The lungs showed a spectrum of changes ranging from little damage to complete consolidation.

In a series of pentobarbitalized cats, when one bronchus was cannulated and the other obstructed prior to exposure to oxygen at high pressure (4 atmospheres) for 3 hours the obstructed side of the lung always showed complete atelectasis and congestion. Tracheal insufflation brought about a dramatic return to the normally inflated state. The cannulated side showed little gross damage after exposure.

The author postulates that the cause of pulmonary damage is simple atelectasis resulting from blockade of the smaller airways by edema formation with resultant absorption of gases peripheral to the obstruction. Neurogenic and hormonal influences may also affect the patency of the distal airways.

Photoscanning Detection of Radioactive Tracers in vivo. M. A. Bender. Science **125**:443 (Mar. 8) 1957.

The author describes the design and application of a device useful in detecting small differences in distribution of radioactive materials within tissues. The signal from a scanning probe is fed through a pulse-height analyzer and used to vary the resistance in a potentiometer which is in series with a small tungsten-filament bulb, so that increasing radiation produces increasing brightness which is recorded directly on film. With this equipment, one can gain a 95 per cent increase in film density with a 10 per cent increase in count rate. Two tumors thus demonstrated in humans are illustrated and discussed briefly.

Cholinergic Innervation of the Digital Arteriovenous Anastomoses of Human Skin. A Histochemical Localization of Cholinesterase. Harry J. Hurley, Jr., and Herbert Mescon. J. Appl. Physiol. **9**:82 (July) 1956.

Specimens of volar skin of the great toes of five human volunteers were stained for the presence of cholinesterases (method of Koelle). Specific cholinesterase was found in many nerve fibers about the specialized arteriovenous anastomoses of digital skin and about the secretory tubules of eccrine sweat glands. The enzyme was absent about other cutaneous vessels and the ducts of the sweat glands. No significant concentrations of nonspecific cholinesterase were detected about any of these structures. The presence of specific cholinesterase about the digital arteriovenous anastomoses indicates that these vessels possess a cholinergic innervation. On the basis of cited pharmacologic evidence, it is suggested that this innervation is vasodilatory.

Spectral Reflectance of the Skin of Chester White Pigs in the Ranges 235-700 μ and 0.707-2.6 μ. Hans F. Kuppenheim; James M. Dimitroff; Peter M. Melotti; Irven C. Graham, and David M. Swanson. J. Appl. Physiol. 9:75 (July) 1956.

The spectral reflectance of the intact skin of the Chester White pig was measured and compared with that of other experimental animals and of the human. From 235 to 1300 millimicrons, the shape of the reflectance curves of the Chester White pig, rat, rabbit and human is similar. The carotene absorption band appears noticeably only on the human and faintly on the rabbit. Above 1.3 microns all reflectance curves, including the one of the hairless mouse, practically coincide. The low reflectance values above 1.8 microns, probably caused by Fresnel reflection, indicate high absorption independent of the thickness of the skin but do not yet permit identification of the absorber. Earlier results that showed spectral reflectance differences to be caused by differences in pigmentation, in skin blood content and in other skin components, and that manifested themselves only between 300 and 1200 millimicrons have been found valid also for the skin of the Chester White pig.

The Ventilatory Response to Exercise in Patients with Mitral Stenosis and its Relation to Circulatory Dynamics. C. L. Ebnother; A. Selzer; A. O. Stone, and T. V. Feichtmeir. Am. J. M. Sc. **233**:46 (Jan.) 1957.

The relationship between total pulmonary ventilation and oxygen consumption at rest and during exercise was observed in thirty-one patients with mitral stenosis and eighteen patients of comparable age with no demonstrable pulmonary or cardiac disease. Patients with class I and II heart disease (mild mitral stenosis) showed an increase in the oxygen removal ratio (oxygen consumption divided by pulmonary ventilation) in response to exercise which was only slightly less than that of the hospital control group. The oxygen removal ratio of the class III and IV patients (severe mitral stenosis) remained unaltered or fell with exercise. This abnormal response could be correlated to the severity of mitral stenosis as gauged by the elevated mean pulmonary arterial and pulmonary wedge pressures but was unrelated to the exercise-induced changes in cardiac output. The authors conclude that the abnormality in the oxygen removal ratio reflects reduced pulmonary compliance and an altered pattern of breathing rather than a change in hemodynamics.

medical news

Members are invited to send to this office items of news of general interest, for example, those relating to society activities, new hospitals, education, etc. Programs should be received at least six weeks before the date of meeting.

New Booklet Uses Unique Communications Technic to Get Across Facts About Doctors

"What Everyone Should Know About Doctors" is a new booklet that uses a new picture-and-word scriptographic technic to present basic facts about doctors. It is designed for lay distribution through employee reading racks, mailings by large industrial and insurance firms and other means.

This is a new approach to a continuing health problem — how to get people to understand the importance of physical check-ups. Many of the public are not aware of the need, and others are afraid of what they'll find. On both counts, more knowledge is needed.

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"What Everyone Should Know About Doctors" is published by the Channing L. Bete Company, Inc., Greenfield, Mass. Individual copies are available at fifteen cents each.

Electronic Device Helps Breathing

An electronic device that permits iron lung victims to breathe for themselves instead of having their respiration forced by machinery was reported by Dr. L. H. Montgomery, Vanderbilt University School of Medicine, to the Institute of Radio Engineers' meeting in New York.

The system, although still in the experimental stage, makes use of the few active chest muscles which continue to contract when the patient tries to breathe. Even in the severest cases of paralysis, there are always a few of these active muscles left.

When they do contract they are not strong enough to accomplish the breathing job, but they generate minute voltages which can be detected by sensitive electrodes placed on the skin. These voltages are fed to an electronic system which amplifies them and then uses them to control the flow of air to and from the iron lung or other respiratory device as the patient needs, Dr. Montgomery reported.

Aside from the greater comfort, the system is a tremendous boost to patient morale. In presently used respirators the patient is compelled to eat, drink and even talk in rhythm with the monotonous push and pull of a motor-driven air pump.

The electronic control now enables the patient to control his own breathing to suit himself.

The equipment is still in the experimental stage, Dr. Montgomery emphasized.

Attack on CV Disease

The launching of the first, nationwide cooperative research attack against cerebral vascular disease was announced recently by Surgeon General Leroy E. Burney of the Public Health Service. This disease, commonly known as "stroke," is the nation's third-ranking killer. Ten medical research centers in nine states have already joined in the program, and it is expected that 35 to 40 institutions will ultimately participate, Dr. Burney said.

The program, which is expected to run five or six years, is under the auspices of the National Institute of Neurological Diseases and Blindness of the Public Health Service's National Institutes of Health.

The new cerebral vascular research program was made possible by Institute grants totaling $172,000 to the various participating organizations. The grants were recommended by the National Advisory Neurological Diseases and Blindness Council earlier this month. The cooperative program is supplemented by 29 current individual projects directed to research on various aspects of cerebral vascular disease and supported by Institute grants totaling about $250,000.

The cooperative investigation will make possible the study of thousands of patients who either have suffered a stroke or who show clinical signs indicating that a stroke might be coming on. The program is specifically concerned with patients suffering from cerebral vascular disease involving hemorrhage, blood clots, blood tumors (aneurysms) and malformations of the arteries or veins of the brain.

The research results are expected to shed new light on the nature and causes of strokes and to open the way to more effective treatment methods. Relatively few data are now available on the effectiveness of the various methods currently in use.

Another aim of the cooperative program is to make possible the more accurate selection of stroke patients most likely to benefit from surgical or non-surgical therapies.

Data collected will be collated and evaluated at the University of Iowa, Iowa City, one of the cooperating institutions. Both the Department of Neurology and the University Hospital will participate.

Other medical facilities cooperating in the new research program are those of the University of Minnesota, Minneapolis; Massachusetts General Hospital, Boston; University of Michigan, Ann Arbor, Mich.; Duke University, Durham, N. C.; University of Pennsylvania, Philadelphia; Columbia University, New York; Indiana University, Bloomington, Ind.; Buffalo General Hospital, Buffalo, N. Y.; Washington University, St. Louis.

America Is Backward

America is a backward country when it comes to providing a stimulating social environment for people who retire at 65, Dr. Benjamin Boshes, Northwestern University Medical School, told the annual clinical conference of the Chicago Medical Society meeting in Chicago.

"Too few men have the ability for full-time recreation. They do not know how to play. They are much better equipped to work. When their occupation, which is actually their recreation, is taken away from them, they are literally lost," he said.

Enforced retirement frequently brings a loss of direction and motivation, and may cause disturbances which are in no way related to the actual physical aging of the body, Dr. Boshes reported.

"The outcome is considerable deterioration of personality, frequently a depressive reaction, and with it a tremendous acceleration in the aging process," he said.

What appears to be a "dementing process" in an older man or woman is frequently a mental reaction which disconnects the person from reality. There is a loss of attention and interest and the individuals are unable to work out a new pursuit for themselves.

But careful evaluation shows little organic loss and, with proper care, the person can be often brought back into reality, he reported.

Medical Schools Create Oversupply of Specialists

The nation's medical schools are not giving adequate training in general medical practice and have helped create an oversupply of specialists, Dr. Malcolm E. Phelps of El Reno, Okla., newly elected president of the American Academy of General Practice, told members of the Academy meeting in St. Louis.

A man can be a trained specialist but, at the same time, an inadequately trained general practitioner, Dr. Phelps reported.

The concentration of specialists in the more populated areas has resulted in an intense competition for patients. Because of it, many specialists have been forced for economic reasons to enter general practice, he pointed out.

Unless the country's family doctors take an active part in shaping professional policy, "selfish and unscrupulous persons may soon further deny them the opportunity of performing many services for which they are adequately trained," he said.

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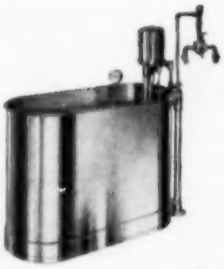

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Bulletin

of the

GREENE COUNTY MEDICAL SOCIETY

Springfield, Missouri

VOLUME XV NOVEMBER, 1956 NUMBER 11

Editorial ¶---†--#§--‼

Medical writing *,†,‡-d is growing so documented [1] and tedious [2-8] that we [9] wonder [10-12] if a writer [13] might not defeat his purpose as an author [14] by scaring off his readers #

It is commendable ¶ for the journalist to comfort [15-17] his public by assuring it # that he has actually read the references himself [1,12,13] However a certain vertigo [3-6,9] must be induced in the cerebrums of innocent ‖ subscribers by the whirring visions of neverending § little figures looking like flyspecks [18-27] on his eyeglasses †

May we suggest that less of these references would greatly facilitate the reading process. The defenseless reader who, after all, only wants to learn what the heck is in the article should find this unadorned type of writing much more relaxing. Ah, yes, very relaxing. Yas, quite relaxing. So-o-o-o-o relax-z-z-z-z-z-z-z.

*,†,‡-d An ungrammatical term by which the author means to convey writing confined to subjects dealing with medicine. See previous articles by author.

If any.

¶ The author takes no responsibility for this statement.

‖ A relative, not absolute, designation as shown by the equation $\sqrt[3]{x-y} = \frac{x}{y-z}$

§ Really, a rather careless choice of adjectives.

† Presuming that he (or she) wears them.

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Dr. Wilfred E. Wooldridge, editor of the "Bulletin" of the Greene County Medical Society, Springfield, Mo., each month comes up with a delightful page. He has very kindly given me permission to reproduce his last November editorial, which gave me, and I hope will give you, a chuckle. I think one of the reasons why some doctors fail to read much good material in their journals is simply because, due to the excessive documentation, they get bored stiff with the chore. Anyhow, it's all in fun and I can visualize Dr. Wooldridge with a twinkle in his eye and tongue in cheek.

Hope you are planning to attend the two-day session of the American Institute of Ultrasonics in Medicine, September 6-7, Hotel Statler, Los Angeles

Cordially,

C. J. Birtcher, *President*
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